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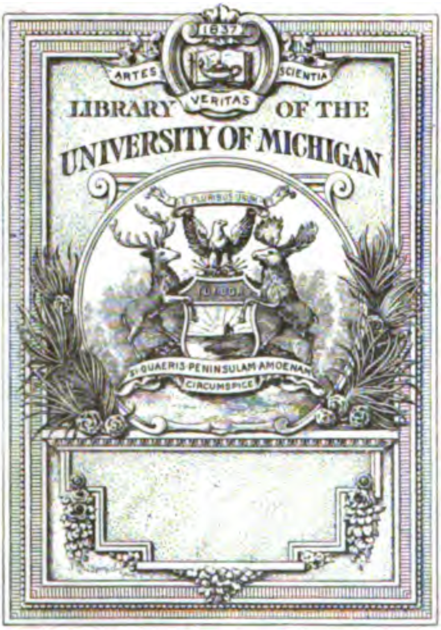
THIRD ANNUAL REPORT
OF THE
STATE ENTOMOLOGIST
OF INDIANA

BENJAMIN W. DOUGLASS

1909-1910



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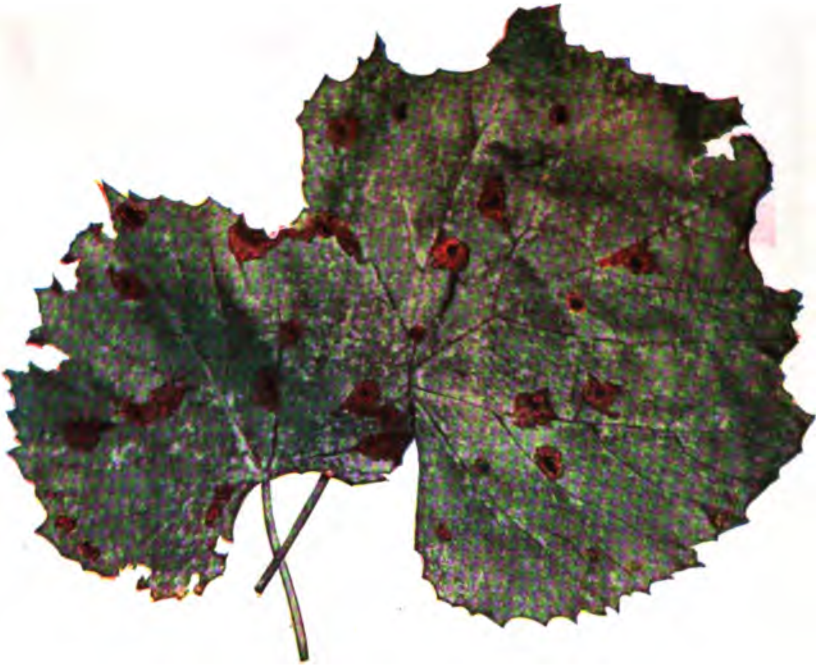
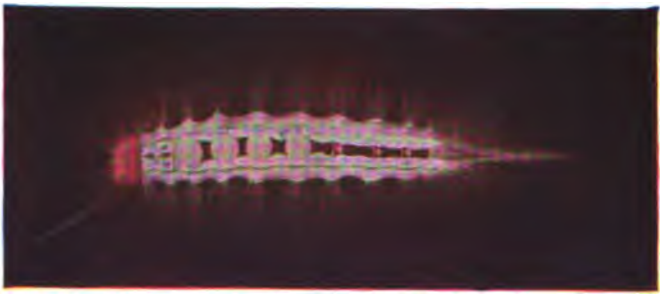
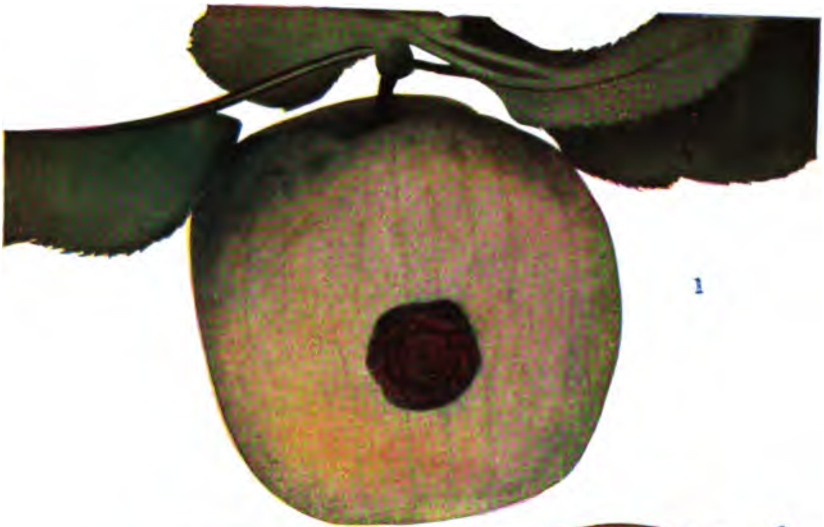




Grape leaves showing spot caused by Black Rot. Page 182.
Larva of the Tussock Moth. Page 116.



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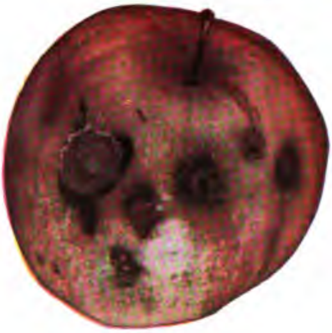

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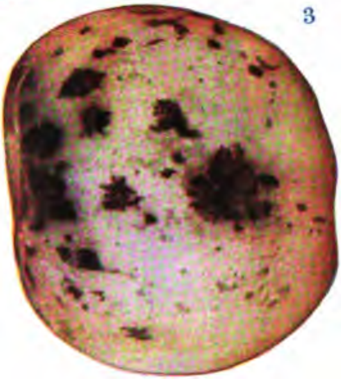

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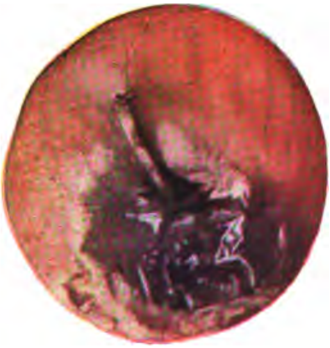


4

No. 1. Pink spore masses on Bitter Rot. Page 138.
No. 2. Apple Scab. Page 145.
No. 3. Apple Blotch. Page 135.
No. 4. Soft Rot or Blue Mold. Page 164.

THIRD ANNUAL REPORT

OF THE

Indiana STATE ENTOMOLOGIST

OF INDIANA

BENJAMIN W. DOUGLASS
1909–10

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING
1910

THE STATE OF INDIANA,
EXECUTIVE DEPARTMENT,
OCTOBER 13, 1910.

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statement.

OFFICE OF AUDITOR OF STATE,
INDIANAPOLIS, November 17, 1910.

The within report, so far as the same relates to moneys drawn from the State Treasury, has been examined and found correct.

JOHN C. BILLHEIMER,
Auditor of State.

NOVEMBER 17, 1910.

Returned by the Auditor of State, with above certificate, and transmitted to Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

MARK THISTLETHWAITE,
Secretary to the Governor.

Filed in the office of the Secretary of State of the State of Indiana, November 17, 1910.

FRED A. SIMS,
Secretary of State.

Received the within report and delivered to the printer, November 17, 1910.

A. E. BUTLER,
Clerk Printing Board.

LETTER OF TRANSMITTAL.

OFFICE OF STATE ENTOMOLOGIST,
BENJAMIN W. DOUGLASS.

INDIANAPOLIS, October 13, 1910.

HONORABLE THOMAS R. MARSHALL, *Governor of Indiana:*

My Dear Sir—It is my pleasure to present herewith the third report of this department. The report deals with the various activities of the department during the past year, and in addition discusses in detail the subjects of Apple- and Grape-growing in Indiana. One section is also devoted to an account of a year's management of the apiary.

The illustrations, practically all of which have originated in the department, are considered necessary for a proper understanding of the text.

Respectfully,

BENJAMIN W. DOUGLASS,
State Entomologist.

FINANCIAL STATEMENT.

1909–10.

B. W. Douglass, salary	$2,500 00
F. N. Wallace, salary	1,200 00
George S. Demuth, salary	1,200 00
Everett Smith, salary	1,200 00
E. A. Dickson, salary	1,083 31
E. F. McCormack, salary	975 00
Field work	8 00
H. S. Chamberlain, salary	19 50
Clifford Bartlett, salary	300 00
William Ziegler, salary	30 00
E. S. Miller, salary	12 00
Paul White, salary	33 00
Harry Dietz, salary	80 00
F. B. Wade, salary	117 00
Walter Baker, salary	4 50
A. J. Phinney, salary	225 00
C. H. Baldwin, salary	162 00
D. W. Erbaugh, salary	165 00
Telephones	116 05
Telegrams	17 43
Express	582 15
Postage	650 00
Hotel expenses	1,111 41
Transportation	1,191 20
Livery	517 55
Office expenses	486 75
Laboratory	252 88
	$14,239 73

Appropriation	$15,000 00
Expenditure	14,239 73
Returned to the State	$760 27

An itemized account of the above expenditures is on file with the Auditor of State.

INTRODUCTION.

It has been my intention in writing the following report to depart very radically from the form adopted in my previous publications. I feel that the first two reports of this department have thoroughly covered the field of injurious insects and plant diseases, and that the current report should enter more into detail regarding some particular branch of the subject. Accordingly the following pages will be very largely devoted to the discussion of apple- and grape-growing in Indiana.

There are few people who realize the possibilities offered by the cultivation of these two fruits. Indiana's rank as an apple-producing State has been low simply because the typical Indiana orchard has, from time immemorial, been a neglected orchard. The State is covered with small orchards, most of which are totally uncared for, but all of which could be made to produce fruit of the first quality. Few farmers realize this fact. Many of those who do realize it do not know just how to accomplish the desired results. It is the intention to have this report supply just this kind of information. In the last few years apple-growing on a large scale has been started in several places in the State, and there is no reason why large commercial orchards should not be a success. It is a demonstrated fact that perfect fruit can be produced here, and it is of better quality and flavor than the fruit of the West. Land suitable for orchards can be had at a reasonable cost, labor conditions are better than in the West, and there is an available market of such size that it will be practically impossible to over-supply it. There is no reason why Indiana should not only grow all of the apples consumed in the State, but ship large quantities to other States as well. As it is, thousands of carloads of apples are shipped into this State every year. There has been some claim as to the uncertainty of the apple crops of Indiana owing to frost. In the neighborhood of Indianapolis careful records show that in the past thirty years there have been only two total failures from this source. Near Greenfield there have been only two losses in thirty-seven years. Other sections of the State show even better records than these.

Most of the crop failures in the State can be traced *directly* *to neglect.* If the farmers of Indiana tried to grow corn in the same slipshod way that they grow apples, this State would be bankrupt. Our orchards should be, and I am convinced will be, a great source of State wealth in the future.

Grape-growing is another branch of agriculture that is vastly underdeveloped in this State. At the present time Indiana ranks tenth in the grape-producing States of the Union, but she should be only half as far down the scale. The steep hillsides of southern Indiana are especially adapted to vine culture, and should be extensively utilized in this way.

In addition to the general subjects of apple-growing and grape-growing, I have included a few remarks on a number of insects that seem worthy of especial notice at this time.

One part of the report is devoted to the bee industry. This minor branch of husbandry is more widely practiced in the State than is generally supposed. From an estimate made on our inspection work it appears that the honey produced in the State annually is worth about one million dollars. If all of the bees of the State were properly managed this estimate could, at least, be doubled—possibly quadrupled. Mr. Demuth's contribution on the year's management of the apiary should be read by all beekeepers, as it represents twenty years' experience in the control of the honey bee.

NURSERY INSPECTION.

As usual, the nursery inspection work was started the first of June and carried on through the summer. The general condition of the nurseries of the State was very gratifying, and shows a decided improvement from year to year.

While San Jose scale continues to exist in a number of localities where trees are grown, all such nurseries are required to fumigate all stock which they sell. In this way the buyer of trees is perfectly protected and need not be afraid to plant any tree grown in Indiana nurseries.

SMALL FRUIT PLANTS.

It appears that this industry is rapidly growing in Indiana. At least a dozen new names have been added to our nursery list this season, and most of them are men who devote their attention to growing small fruit plants. The following list contains all of the names of nurserymen who have received a certificate up to the time that this publication goes to press:

LIST OF INDIANA NURSERYMEN.

Abraham Brothers, Martinsville, Ind.
J. K. Anglin, Etna Green, Ind.
J. M. Alstott, Corydon, Ind.
T. A. Baldwin, Oxford, Ind.
A. J. Barnard, Westville, Ind.
M. Barnes & Co., College Corner, Ohio.
E. H. Beck, Michigan City, Ind.
Jennie B. Bennett, Scotland, Ind.
A. S. Bennett, Lafayette, Ind.
Samuel Billingsly, Greenwood, Ind.
C. A. Bird, Depauw, Ind.
E. E. Bird, Depauw, Ind.
L. M. Blankenbaker, Borden, Ind.
W. T. Blankenbaker, Borden, Ind.
Mercer Brown, Spiceland, Ind.
Brownstown Nursery Company, Brownstown, Ind.
Porter Broshears, Boonville, Ind.
H. F. Buck, Elberfeld, Ind.
S. H. Benton, Washington, Ind.
Burkhart & Son, Southport, Ind.
W. O. Burns, Pekin, Ind.
J. S. Burgess, Depauw, Ind.
J. P. Burgess, Depauw, Ind.
D. W. Callahan, Pekin, Ind.
P. H. Callahan, Pekin, Ind.
Capital City Nursery Company, Greenfield, Ind.
P. A. Card & Son, Greenfield, Ind.
J. F. Cathcart & Son, Bristol, Ind.
Alva Cathcart, Bristol, Ind.
Herbert Cavanagh, Wolcottville, Ind.
G. W. Childers, Valeene, Ind.
L. B. Cochran, Greensburg, Ind.
Lamar Collins, Underwood, Ind.
Frank Congdon, Bristol, Ind.
J. L. Cook, Warsaw, Ind.
A. M. Cosner, Stilesville, Ind.
Cunningham Nursery Company, Rising Sun, Ind.
H. P. Dean, Indianapolis, Ind.
Dora Dill, Converse, Ind.
Jerry Dutter, Angola, Ind.

E. S. Eickhoff, Julietta, Ind.
Joseph Egloff, St. Meinrad, Ind.
Fred Fordyce, Borden, Ind.
Willard Fullhart, Muncie, Ind.
W. H. Gaar, E. Germantown, Ind.
Milton Gaar, Cambridge City, Ind.
S. C. Gainey, Doans, Ind.
W. F. Gallamore, Bloomfield, Ind.
D. M. Garber, Pierceton, Ind.
F. B. Garrett, Burns City, Ind.
R. N. Gast, Akron, Ind.
L. H. Girton, Bristol, Ind.
Albert Goehler, Urbana, Ind.
J. K. Graham, New Albany, Ind.
Daniel Gray, Borden, Ind.
Charles Gray, Pekin, Ind.
Alvia Gray, Pekin, Ind.
Charles Graham, Sellersburg, Ind.
Harry Haas, Terre Haute, Ind.
Halleck Nursery Company, Fair Oaks, Ind.
Joseph Haines, Hatfield, Ind.
Smith Hazen, Hatfield, Ind.
Henby & Son, Greenfield, Ind.
E. G. Hill & Co., Richmond, Ind.
C. M. Hobbs, Bridgeport, Ind.
J. L. Holsclaw, North Vernon, Ind.
L. V. Hopkins, Maxwell, Ind.
M. J. Huber, Deerfield, Ind.
Willard Hurst, Pekin, Ind.
William Hurst, Pekin, Ind.
Heller Brothers, New Castle, Ind.
J. H. Hoppes, Red Key, Ind.
Don J. Henry, Laporte, Ind.
B. W. Hurraw, Butler, Ind.
C. A. Ireland, Brownstown, Ind.
Indianapolis Forest Nursery Company, Indianapolis, Ind.
H. E. Jackman, Waterloo, Ind.
J. A. Jarrett, Keystone, Ind.
E. E. Jones, Plymouth, Ind.
Nathan Karnes, Pekin, Ind.
Thomas Keele, Westville, Ind.

Samuel Kelley, Alert, Ind.
Robert Kent, Haughville, Indianapolis, Ind.
S. W. Keplar, Pulaski, Ind.
Ben Knaub, North Vernon, Ind.
Vernon Krider, Middlebury, Ind.
William LaHayne, Chesterton, Ind.
Frank Leroy, Laporte, Ind.
David Lewis, Fairmount, Ind.
J. W. Lucas, Bloomfield, Ind.
O. Lutz, Portland, Ind.
Charles McClaren, Corydon, Ind.
Joe T. McClaren, Corydon, Ind.
McCormack & Osborn, Burns City, Ind.
R. L. McCoy, Hatfield, Ind.
Hiram McFeron, Columbus, Ind.
William McElderry, Princeton, Ind.
D. A. McGinnis, Andrews, Ind.
Sylvanus McKinley, Borden, Ind.
B. F. Mason, Martinsville, Ind.
H. H. Meeker, Crown Point, Ind.
Meredith & Son, Koleen, Ind.
Grant Mills, Redkey, Ind.
J. G. Milhous, Butlerville, Ind.
Frank Moffit, Carmel, Ind.
G. N. Moyer, Laketon, Ind.
Asbury Murr, Depauw, Ind.
A. M. Murray, Goshen, Ind.
William Murray, Goshen, Ind.
Charles Nation, Gilead, Ind.
George Neet, Valparaiso, Ind.
J. M. Noble, Sellersburg, Ind.
Alfred Nufer, Bremen, Ind.
Arthur Osborn, Spiceland, Ind.
R. J. Overman, Danville, Ind.
Henry Packwood, Borden, Ind.
R. T. Patterson, Bloomfield, Ind.
W. W. Phelps, Westfield, Ind.
Portland Nursery Company, Portland, Ind.
A. C. Preble, Marion, Ind.
Purdue University, Lafayette, Ind.
Amos Ragle, Elnora, Ind.

G. C. Rape, Farmland, Ind.
W. C. Reed, Vincennes, Ind.
Lee Ripperdan, Valley City, Ind.
G. L. Roberts, Depauw, Ind.
Sig Rogers, Bloomfield, Ind.
W. H. Reed, Hanover, Ind.
C. H. Scott, Winamac, Ind.
Thomas Shields, Anderson, Ind.
Shields Brothers, Charlottsville, Ind.
A. B. Sibert, Rochester, Ind.
David Sinclair, Mauckport, Ind.
H. M. Simpson & Son, Vincennes, Ind.
Sleeper Brothers, Fowler, Ind.
Jas. Sloan, Washington, Ind.
J. M. Snodgrass, Kirklin, Ind.
S. A. Snoddy, W. Lafayette, Ind.
E. E. Smith, Warsaw, Ind.
J. E. Smith, Muncie, Ind.
B. F. Stalker, Borden, Ind.
Wilbur Stout, Mooresville, Ind.
H. H. Swaim, South Bend, Ind.
E. Y. Teas, Centerville, Ind.
Charles Quillen, Mooresville, Ind.
G. C. Terrell, Pekin, Ind.
F. Walker & Co., New Albany, Ind.
Thomas Ward, St. Mary's, Ind.
Ira Weaver, Middlebury, Ind.
J. W. Wilson, North Judson, Ind.
W. H. Wines, Gilead, Ind.
G. W. Winchell, Tobinsport, Ind.
J. M. Wickizer, Plymouth, Ind.
C. H. Weber, Greenfield, Ind.
Lee A. York, Battle Ground, Ind.
John Young, Odon, Ind.

EXHIBIT AT COLUMBUS FAIR.

ORCHARD INSPECTION.

The orchard inspection work is a branch of the service that has been developed within the past two years. Previous to that time practically all of the inspection work of the department was confined to the inspection of nurseries, owing to the fact that the appropriation for the use of the department was not only limited, but the department was not permitted to employ deputies for inspection work. Accordingly one man was kept busy simply looking after the work of the nurseries. As it is now the orchard work has already outgrown the nursery work, and a number of men are constantly employed in this branch of inspection.

Last winter a number of localities were covered with what we might term a "blanket inspection." Under this system every piece of property in the inspected area was gone over, and wherever any injurious insect conditions were found they had to be remedied by the owner or the person in charge of the property. In carrying on the work in this way we, of course, meet with people who are simply obstructionists and who do all they can to prevent the success of the work. As a rule, however, these people are the most enthusiastic when they once see the result of the work which we require of them. In one locality last year a man was very strenuous in his resistance of our efforts, but after he had sprayed his trees and had seen their improved condition he was mad because we had not made him do the work three years before.

In some localities where the inspection work was carried on we have held some demonstration meetings to show the farmers just how the work should be done. These meetings have been in some cases very well attended, and I expect, during the coming winter, to extend them into new localities.

Many farmers were reached through farmers' institutes last winter and we are hoping to reach still more the coming season. The department now has a corps of excellent lecturers who are ready to go out at any time to any farmers' gathering. At the county fairs at Columbus and Boonville the department had an educational exhibit which attracted a good deal of attention. This was the first year that the department had ever attempted to make an exhibit at the county fairs. The two fairs selected were more in the way of experiment than anything else. They were so successful that next year more places should be taken in in the same way.

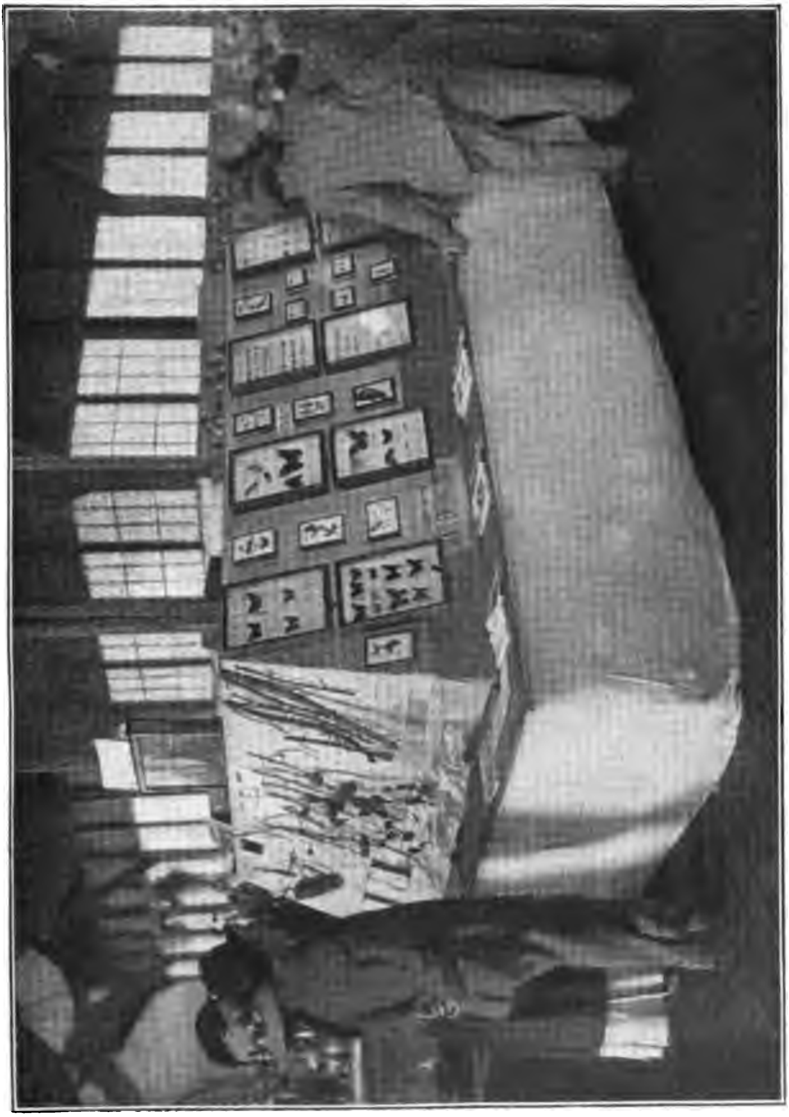


EXHIBIT AT THE STATE FAIR.

The annual exhibit at the state fair was on a more extensive scale than ever before, and attracted thousands of visitors, probably more people being reached through this exhibit than through any similar amount of effort put out by the department.

IMPORT INSPECTION WORK.

As usual all nursery stock entering Indiana from foreign countries was inspected when it reached its destination. This work has been shown to be very necessary if we are to prevent the entrance of the Brown Tail Moth into Indiana. I explained this matter very fully in my last year's report and showed the necessity for careful work along this line. Our inspections of last spring indicated that the conditions in the European nurseries were but little improved over the previous year; and we will probably have to keep a sharp watch on all European shipments for some time to come.

When the infested shipments first started to arrive in America, about two years ago, all of the States promptly took charge of the inspection of foreign stock with the exception of the States of Missouri and Iowa. These two States neglected to inspect the imported stuff, and as a result we may expect to find the Brown Tail Moth in either of these localities. For this reason I have decided to refuse to accept certificates from nurseries located in Missouri or Iowa, and accordingly all stock coming from these two States must be inspected upon coming into Indiana. This situation has shown the necessity for some change in our nursery law that will enable us to more thoroughly prevent the introduction of suspicious stock into the State. I believe that all outside nurseries should be required to secure their shipping tags from this office.

One case that has shown the necessity for this import inspection work was at the E. G. Hill & Company's greenhouses last fall, in which three cases of rose bushes contained one hundred and nine nests of the Brown Tail Moth. This was the first shipment of this sort that was found to be infested, and shows the necessity for keeping a sharp lookout on greenhouse stock as well as on nursery stock. We are at present inspecting everything that comes into Indiana from foreign countries that could possibly harbor any of these insects.

CROWDS WATCHING BEE DEMONSTRATION AT STATE FAIR.

INSPECTING NURSERY STOCK IMPORTED FROM EUROPE.

Hundreds of Brown Tail Moth nests have been found on stock of this sort.

MILES OF SCALE-INFESTED OSAGE ORANGE HEDGES HAVE BEEN CONDEMNED.

BEE INSPECTION WORK.

During the past season some inspection work was done in each of thirty-five counties. In some of these counties a systematic and thorough canvass was made, while in others but a few apiaries were inspected.

A few new outbreaks of the diseases were discovered and promptly stamped out. In general the infested localities correspond largely with those of last season. The following is a summary compiled from the reports of field work during the season of 1910:

Total number of visits	529
Total number of colonies inspected	5,783
Colonies affected with American Foul Brood	402
Colonies affected with European Foul Brood	358
Total colonies diseased	760
Total colonies in box hives	87
Total colonies in frame hives with comb built crosswise	125

Percentage of colonies found diseased, 13.1. During the season of 1909, 6,036 colonies were inspected, 1,431 of which were diseased, or a percentage of 23.7.

LABORATORY WORK.

During the last year there have been hundreds of specimens sent into the Laboratory for identification. Much of this work has been done by Miss McCormack, who has prepared the matter relative to the diseases of the apple and the grape which appears in another section of the report.

OFFICE WORK.

During the year the office work has grown in keeping with the general growth of the department, and the department has already outgrown its quarters, which were obtained last year from the Board of Forestry.

APPLE-GROWING IN INDIANA.

By an old law all sources of supply are stimulated or retarded accordingly as the demand is great or small. In years when great demand causes the price of wheat to pass the dollar mark, we can expect to find the farmers planting more of this grain to meet the growing demand.

A STORY OF NEGLECT.

In following the history of apple-growing in Indiana we find that the demand for apples not only came with the first settlers, but was even anticipated by one of the earliest pioneers. Before the hardiest homesteader had broken his first field in the wilderness there came tramping and canoeing through the woods one of the most interesting voyagers of that early time. This man, John Chapman, spent his time in bringing to the new country seeds and young trees of the apple. It is said that he carried with him his ax and spade, and with these crude implements planted apples in scant clearings which he made. Among the Indians he was rated as "gawanadapined," a crazy man, but had they known the quality of the fruit he brought they would have had a different sort of welcome for our first horticulturist.

Unfortunately the Indian's knowledge of apples was limited to one variety of haws (*Craetagus mollis*) and to the wild crabs of the woods. These constituted the only representatives of the apple growing in the American woods which could ever by the wildest stretch of imagination be considered edible. All of the apples which we know in our orchards have been brought to this country from Europe and perhaps from some parts of Asia. Of course, many varieties have been produced in America, but always from stock of foreign parentage. The most skillful horticulturist has failed to tame the acid crab of the native forest or to increase the size of the red haw.

The trees which Johnny Appleseed planted were probably mostly seedlings, and their fruit was doubtless poor. I know of only one such tree in Indiana today. It stands (or did until recently) near Spiceland, in Henry County. I have talked with Joe Unthank about this tree, and he tells me that in his boyhood the tree bore quantities of fruit which he then considered excellent. His judgment now is that the apples could not compare with the best of our orchard fruits today. They supplied the wants of the early agriculturist, and in that day were doubtless rare fruit.

The trees planted by John Chapman thrived in the new soil and bore fruit for the settlers. Doubtless these old trees were a source of inspiration for the early comers and were an incentive to plant more trees of the same sort. Certain it is that the "home orchard" was a feature of the early homesteaders, and the site of many a pioneer's cabin is marked today only by the ragged stumps of a few old apple trees.

These early orchards were not planted to supply a commercial demand, for no such demand existed at that time. It was the planter's intention only to supply his immediate needs. While there was a market for the fruit in the older settlements in the East, transportation facilities were such as made it impossible to ship the fruit out of the district in which it was grown.

As time went on and our agricultural commonwealth developed, the farmer's attention was turned, not to fruit growing, but to crops which would yield a quick return. This, of course, meant grain farming, and as most of the State is admirably adapted to the growing of grain, fruit culture did not advance to the commercial status which it deserved.

The apples which were grown on the Indiana farms a generation ago and more were of a quality that would compete with any apple that ever came out of the West.

This fact is abundantly testified to by many of the old farmers who are still living. The perfect fruit of the old orchards can be accounted for only on the ground that most of our fruit pests are not indigenous to this section. Consequently fruit-growing became a sort of automatic adjunct to general farming. No special care was given to the orchards, but they bore large crops of perfect fruit in spite of their neglected condition.

In course of time the Codling Moth, the chief insect enemy of the apple, made its way to this section of America, as it since has to all sections of the country wherever fruit is grown. Other insect pests put in an appearance or adopted the apple in preference to their native food, fungus diseases came to us, probably from the South, and almost before we knew it apple-growing had ceased to be the easy matter it had been for years. The farmer's attention had meantime been centered on the growing of grain, and fruit-growing, with its increasing difficulties, became more and more neglected.

"You can't grow apples in Indiana" is a statement which has grown out of a combination of ignorance and indifference. The growing of grain has in the past been so profitable that the possibilities of the orchard as a money-maker have been overlooked.

With our increased population and excellent transportation facilities, no State is in a better location for supplying the market with fine fruit than is Indiana, and it is a demonstrated fact that such fruit can be grown here at the present time if it is given intelligent care.

The demand for *first-class* apples today is greater than ever before, and is constantly increasing. This demand, of course, does not apply to the runty fruit of the neglected orchard. I have had many complaints from alleged fruit-growers that they could not sell apples after they had raised them. The fruit they offered might more properly be termed hog feed than first-class apples. No one need fear any lack of market if he will grow good fruit and see that it is properly packed for market.

After several years' experience in the apple orchards over the entire State of Indiana, it would be rather difficult for me to say that any section is better for apple-growing than any other locality. I have seen perfect fruit growing in nearly every section of the

State and believe that there are very few places in the State where fine apples cannot be grown if they are given equal care and attention.

The apple is a fruit which does well in a great variety of soils. I have seen splendid fruit grown on heavy clay soils through the South, and in northern Michigan I have seen very excellent apples grown in a soil which is almost pure sand. The soils in Indiana present practically all the variations between these two extremes, and it is certain that most of the Indiana soil will grow fruit of good quality. I believe that the red clay which is found in some of the southern Indiana hills will produce fruit of, perhaps, a little better color than that which is grown on other soils. I do not believe, however, that this point has been definitely settled one way or the other. I have been sufficiently impressed with the red clay soil, however, that for my own part I would prefer to plant an orchard on such soil, provided other conditions were equal.

Regardless of the kind of soil on which the orchard is planted there is one condition which must always be fulfilled if the trees are going to make a good growth and produce good fruit. This condition simply is that the orchard be well drained. Good drainage is natural in some localities, while it is difficult to procure, even by the most perfect system of drainage, in other localities. This is notably true on some of the clay hilltops along the Ohio River, where the soil is heavy and wet throughout the greater part of the summer. I have seen some orchards that were practically a failure owing to the fact that the planter did not recognize the necessity for drainage when the trees were planted. On these heavy clay soils to the south, where the natural slope is not sufficient to produce good surface drainage, good results are sometimes obtained by the use of artificial surface drainage by back-furrowing between the rows of trees. This will produce a slight ridge, with the trees at the top of it, with the slope into a slight valley between the rows. This will tend to cause the surface water to run off more rapidly than it otherwise would and materially tends to keep the soil in better condition as regards moisture. In selecting the site for the orchard in Indiana, I think that we can almost disregard the factor of soils and locate the orchard so as to give it the greatest advantage in regard to drainage, exposure, accessibility, etc. There is one factor in connection with the soil of the southern Indiana hills that should be mentioned at this time. While I do not believe that even a red-clay soil renders sufficient advantage to warrant our going into a remote section in order to obtain such a soil, still the cheap land throughout the southern part of the State is undoubtedly an inducement to any planter to locate his orchard at that part of the country. Good ground for the growing of apples may be obtained throughout the South at prices ranging from ten to twenty-five dollars per acre. Good ground for the same purpose throughout the central and the northern parts of the State cannot be obtained for much less than one hundred dollars per acre, and at that it is often difficult to obtain a location that has some of the natural advantages which the southern hillsides already present.

It has been claimed that new soil, that is land from which the forest has recently been removed, is not so well adapted to apple growing as is old land. This claim is made on the supposed fact that the root-rot disease of apple trees is more prevalent on recently cleared land. In some respects this statement seems to be true, though I have seen bad cases of root-rot in orchards planted on ground that had been cleared for sixty years. I believe that the root-rot trouble can be very largely avoided, even in recently cleared land, by proper care and attention. This, however, will be discussed at greater length under its proper heading with the Apple Diseases.

The soil for the orchard, then, may be of almost any quality—preferably not too poor nor too rich. It must, however, be well drained. This is one point in regard to the orchard soil which cannot be overlooked.

It is impossible to lay down a list of varieties of apples for planting in Indiana and have that list include all of the best varieties for all of the different sections of the State. Accordingly in the following discussion of varieties I shall use the initials S., C., and N., after the name of the variety to indicate the region in which that particular variety will be most likely to succeed, the initials standing for North, Central, and South, respectively. Even with such a limitation it is impossible to include for the different localities all of the varieties which are possibly successful in that locality. The best that a planter can do in setting out an orchard, either for home use or for commercial use, is to make an examination of the small orchards already planted in the locality where he expects to plant his orchard and learn what varieties have been successful in that immediate neighborhood. A distance of a few miles will sometimes mean the difference between success and failure with some given variety of fruit. Following the description of each variety will be a statement as to the length of time which the variety requires before it begins to bear. This statement does not necessarily mean that the trees will bear a commercial crop at that age, but that some fruit may be expected in the length of time mentioned. These dates have been determined from the experience of a large number of planters over the State, and are not the results of guess-work in any case, neither are the extremely early dates of bearing given. There are some varieties of apples that I have found in bearing in the nursery rows on trees that were only two years from the graft. Such early bearing is, of course, unusual, and has no significance to the orchard planter other than to indicate that that variety is one which can be expected to give results within a very short number of years in the orchard. The following varieties are arranged more or less in the order of their season of ripening:

Early Harvest. (N., C., S.) This is probably the earliest good apple which we have. The fruit ripens at about the time of the wheat harvest throughout Indiana, and continues to ripen for several weeks thereafter. The apple is a bright straw color, with crisp, white flesh, and is of excellent quality. The fruit is productive and will make an excellent market apple. To reach its best perfection the Early Harvest must be given good cultivation in the orchard and must be thoroughly sprayed. Four to five years.

Yellow Transparent. (N., C., S.) This is one of the best apples that can be grown in Indiana for an early crop. It is of Russian origin, and is exceedingly hardy throughout our latitude. The tree is somewhat of a dwarf habit, and may be used either as a filler between other trees or the trees may be planted closer together. I think that perhaps the Yellow Transparent trees could be planted as close as twenty feet and still allow plenty of room for the necessary work of the orchard. The fruit ripens in July and is of a beautiful pale yellow color and is well described by the name Yellow Transparent. The flesh is crisp and subacid, making it a most excellent cooking apple, and one that is regarded as a good eating apple by many people. The tree is quite a regular cropper and may be depended upon for a stand of fruit practically every year. Sometimes orchards of Yellow Transparent have the habit of changing off and bearing only on alternate years. I would consider the Yellow Transparent one of the most valuable apples to plant in a commercial orchard, and I would certainly plant one or two trees in every home orchard, as the fruit is the best of the early apples and is very desirable in many ways. Two to three years.

Red June. (C., S.) This is a bright red apple of about the same season as the Yellow Transparent. It is quite hardy throughout its range, and is a good apple for the home orchard. I would not recommend it for commercial planting owing to the fact that the fruit is easily bruised and would not stand long shipment. Where it is grown commercially it has to be handled with almost the same care that is given peaches in order to reach market in first-class condition. The *Wilson* Red June is said to be an improvement over the Red June, but I have not seen it grown in Indiana.

Red Astrachan. This is a Russian apple that has failed to make good in our section of the country. It is almost impossible to grow this apple to perfection, even with the most careful attention and the most thorough spraying. In our experimental orchard this season we gave some attention to the Red Astrachan, but the fruit was a great disappointment—that on the sprayed and the unsprayed trees showing practically no difference in condition. Even the defective fruit, however, was gathered with considerable care, as the apple is unsurpassed for the making of apple sauce. The tree is late in coming into bearing, and even when it does come into bearing it is a somewhat shy producer of fruit. I would not recommend it save for home orchards, where plenty of room is available, and where the owner does not object to experimenting.

Benoni. (N., S., C.) This is one of the best of the early apples, but is not a good apple for commercial growing, owing to the fact that it is of small size. It is hardy throughout most of Indiana and comes into bearing very young, probably in about from four to five years from the time of planting, though I have no well-authenticated dates on this particular variety. The fruit is a good one for the home orchard, owing to the fact that it ripens unevenly and continues to produce ripe fruit through rather a long season. Like the Yellow Transparent, these trees are of somewhat upright growth and can be planted closer than the standard varieties of winter apples.

Duchess. (N., C., S.) This, like the Yellow Transparent, is a Russian apple and is exceedingly hardy throughout the State. I consider the Yellow Transparent and the Duchess as two of the best varieties of summer apples to grow for commercial purposes. The Duchess is a handsome, red-streaked apple of fine flavor and excellent cooking qualities. It is like the Yellow Transparent, in that it grows to perfection with very little attention. These two apples are about the only varieties that I know of that will produce almost perfect fruit without spraying. They are both exceptionally free from apple scab and from other fungous diseases. Like the Yellow Transparent, the Duchess is of compact growth and may be planted as is recommended for the Yellow Transparent. In most cases I think I would confine commercial plantings of early apples very largely to these two varieties on account of their hardiness, their reliability, and excellent qualities. The fruit of either variety will sell on sight, and when the buyer is once familiar with the quality of the fruit he will be always ready for the second order. Two to four years.

Chenango. (C., S., possibly N.) This apple is also known as the Early Strawberry, and sometimes as the Sherwood. Throughout a large part of southern Indiana the apple grows to great perfection, though in some localities it is very subject to brown rot. The tree is not as hardy as the Yellow Transparent or the Duchess, but in the south part of the State the fruit is fairly regular. The apples are large for summer apples, of a "sheep-nosed" shape, light yellow in color, splashed with bright crimson over a large part of the surface. Some fruit will be practically solid red all over. The apple is one of the very handsomest of the summer apples, and where it can be got to market without too long a shipping distance it ought to be a profitable sort. Like the Red June, however, it is a delicate fruit and is easily bruised. It takes almost as much care in handling as the peach. When taken to market the fruit sells at a high price, owing to its good size and unusual beauty. One or two trees should be in every family orchard in the central and southern part of the State. The tree comes into bearing fairly early.

Sweet Bough. (N., C., S.) This is a large, yellow, sweet apple and is probably the best of all the summer sweets. It is probable that no sweet apple should be extensively planted for commercial purposes, owing to the fact that the demand for sweet apples is not great and the price which they bring unusually low. Where high-grade fruit is grown, however, there is a market for a limited amount of sweet fruit, and there is possibly some field for growing this apple on a commercial scale. The Sweet Bough comes into bearing rather early and is a regular, though not usually a very heavy, bearer. The fruit, like many other summer apples, is very delicate, and will not stand very long shipping, though if packed in boxes it can be transported a considerable distance with safety.

Maiden Blush. (C., S.) This is a medium-sized yellow apple with red cheeks on the side exposed to the sun. It is an old variety, of good quality, and is widely known. It seems to be hardy throughout the south half of the State, but is not profitable, for the same reason that the Red Astrachan fails. It seems to be almost impossible to grow perfect fruit of this variety with any ordinary care. It is an excellent cooking variety, and one tree should be in every home orchard. The variety is often used as stock for producing dried apples, making a product that is noticeably white in quality, and therefore bringing a little better price on the market than dried apples produced from other varieties. The Maiden Blush originated in New Jersey and comes into bearing comparatively young.

Gravenstein. (C., S.) This is an apple of German origin of rather large size, yellow in color, streaked with red. The flesh is crisp and tender and of good quality. The tree is a regular bearer, though rather late coming into bearing. Other sorts are possibly more valuable for commercial orchards. Eight years.

Bismark. (N., C., S.) This is an apple of very poor quality, and is mentioned here only because many inquiries are received regarding it. It is possibly the most dwarfed of all apples, the trees frequently bearing fruit when only two or three feet high and in one or two years from planting. This variety is sometimes grown in pots as a novelty. The fruit is large, yellow color, striped and blotched with red. The quality of the fruit, however, is exceedingly coarse and commands no respect from a commercial standpoint.

Rambo. (C., S.) This is one of the very old varieties that is not in common cultivation. The apple is greenish-yellow, striped with red, and is of excellent quality. The fruit does not keep well and is not recommended for commercial planting. A few trees, however, should be in every orchard, either commercial or for home use, as there will always be some sale for this variety. The trees are slow coming into bearing, but are fairly regular bearers after they start. The fruit must be thoroughly sprayed to prevent injury by the apple scab, as this variety is especially susceptible. The Rambo is of American origin. Ten years.

Wealthy. (N., C., S.) This excellent apple originated in Minnesota, and is proving to be a splendid variety for a great range of territory. It will do well in almost any part of Indiana, and is one of the very best commercial apples that can be planted. It is not susceptible to disease and the tree is of vigorous growth. The fruit keeps well and in the northern portion of the State will rank almost as a winter apple. Wealthy apples grown anywhere in Indiana can be kept until late in the winter in cold storage, and can be kept relatively well in ordinary storage. The apple is almost solid red in color and is of excellent quality, making a splendid fruit for dessert or for cooking. The tree comes into bearing very early and I have seen three-year-old trees which had a fair crop of fruit on them. This, of course, was an unusual occurrence and a commercial crop could not be expected in that short length of time.

WEALTHY APPLES FROM A FOUR-YEAR-OLD TREE.

Fameuse (Snow Apple). (N., C., S.) This is an excellent variety and can be planted practically any place in the State. It is not so productive as some other varieties, and possibly will not be a great success commercially. It should be planted, however, in the home orchard, as it is one of the very best early winter apples. Six years.

Wolf River. (N., C., S.) This is probably one of the largest apples grown in Indiana. The variety originated in Wisconsin and is planted throughout a wide range of territory. The fruit is yellowish in color, striped and blotched with red. The fruit and the tree are both very hardy and will stand considerable frost. In quality the Wolf River is exceedingly poor, and is not a good apple to grow on a commercial scale. Its chief value is as a show apple, owing to its large size and beauty. Where the variety is not known its large size will often sell it, but the purchaser is not likely to be fooled the next time, as the poor quality of the apple renders it worthless for practically all purposes.

King (King of Tompkins County). (N.) In some localities in the northern part of the State the King will undoubtedly prove a successful commercial apple. The fruit is large, red and beautiful. In most localities, however, the apple is not productive enough to be made a commercial fruit. This point can only be determined by practical experience in the locality where the orchard is to be located. Six years.

Baldwin. (N.) This standard variety originated in Massachusetts, and has been the great commercial apple of New England for a good many years. The quality is excellent and the fruit keeps well under almost any conditions. It is an apple of firm texture, thick skinned, and an excellent shipper. The Baldwin is not only a good dessert apple, but is one of the very best apples for cooking, and especially for baking. I would not recommend it, except for the northern part of the State, as grown in the south the fruit will not keep well. The only objection to the Baldwin is that it is slow in coming into bearing. When it does finally reach bearing size it is rather a regular cropper and bears large crops. Eight to twelve years.

Northern Spy. (N.) This variety originated in New York and, like the Baldwin, is a splendid apple throughout the East. It is a better quality than the Baldwin, though some people think the Baldwin is the preferable fruit. The Northern Spy is large, of a light red color and exceedingly juicy—somewhat acid. The tree is one of the hardiest of all the apple trees which we have. It resists insect injuries and also fungous diseases. To do well, however, it requires thorough cultivation. The Northern Spy stock is one of the best stocks on which to graft the more tender sort, such as the Grimes Golden, and other varieties which are subject to root troubles. While the Northern Spy may begin to bear at about ten years, commercial crops cannot be expected from it in much less than fifteen or seventeen years. This unfortunate quality makes it a poor variety to plant for commercial orchards. The trees are large-growing and may be planted as shelter belts on the windward side of the orchard.

Banana Apple. This splendid variety originated in Indiana, near Logansport, on the farm of David Flory. In quality the Banana apple is one of the very best dessert apples we have. The skin is pale yellow, with very delicate pink blotches on the side next to the sun. The flesh is exceedingly tender and the entire apple has a delightful fragrance somewhat suggestive of a banana. The fruit is of such splendid quality that it will pay to use the necessary precautions in preparing it for shipment. It is essentially a fruit for the fancy market, and must be handled almost as carefully as the peach to reach the market in perfect condition. If it reaches the market in any other condition it will be practically unsalable. It is a rather interesting fact that this variety, which originated in Indiana, has developed into one of the most profitable varieties of the Western orchards. In fact, very few of the trees are planted in Indiana, and I know of only one or two places where commercial orchards of this variety exist. Where the trees have been planted and cared for, however, the Banana is proving to be an excellent sort for Indiana growers, and I think that the present neglect of the variety will rapidly be overcome as soon as the apple-growers realize what they have been missing. Four to six years.

Jonathan. (N., C., S.) This splendid variety is a seedling of the old Spitzenberg, but it is an improvement on it. It is one of the most beautiful red apples that we have and has a peculiar spicy, high-flavored quality, with tender and juicy flesh, making it an excellent apple not only for the home orchard, but for commercial orchards. The Jonathan tree is hardy, bears early, and is long-lived. The fruit keeps well and stands shipment in good shape. While the apples are not large, they are of uniform size, smooth, clean, and command a good price at all times. This is another variety that has made a good record in the West, especially in the Hood River region of Oregon.

THE ORIGINAL BANANA APPLE TREE.

Mr. David Flory, the originator, in front of the tree.

Rome Beauty. This is a beautiful, large, red apple, which originated in Ohio and is one of the very best sorts for this region. It is not only hardy and productive, but is of splendid quality. The trees come into bearing at an early age and produce regular crops after they once start. In some sections of the State the Rome Beauty has not been a hardy tree, having yielded to root rot and blight in several sections. In most parts of the State, however, I believe that the Rome Beauty will be as good a variety as can be planted for the commercial orchard, and should by all means be in every home orchard. Three years.

Grimes Golden. (N., C., S.) This is an old-time favorite that has never lost its popularity, though I am perfectly free to confess that I, personally, could never see where this popularity was gained. Possibly my prejudice is due to the fact that I never did like a yellow apple, and when there are so many splendid varieties of red apples that can be planted, I do not believe that I would ever be tempted to plant the Grimes Golden very extensively. However, with many people this sort is a favorite, and it has proved to be an excellent commercial variety in some sections of the State. The tree is not hardy, and were it not for the fact that it comes into bearing young it would not be a profitable sort to plant in any locality. Propagated by any of the ordinary means the Grimes Golden is an exceedingly short-lived tree, almost invariably succumbing to root rot before it has reached the age of fifteen years. In a commercial orchard I would be tempted to plant the variety as a filler between other first-class varieties. Where the grower insists upon planting the Grimes Golden it should be top-grafted on some other stock, preferably the Northern Spy, as the roots of the Northern Spy are resistant to disease and also to the root aphis, and in this respect make an excellent stock for grafting the tender sorts like the Grimes Golden. In all cases the grafting should be done high enough that the wood of the Grimes Golden will never come in contact with the soil. By following this system of propagation the Grimes Golden can be successfully grown to almost any age. Five to seven years.

York Imperial. (N., C., S.) This variety, which originated in Pennsylvania, is of greenish-yellow color, often covered with bright crimson. The fruit is very handsome and of good keeping quality, but not regarded as a fine apple. The good keeping qualities of the fruit, and the fact that it is an annual bearer, makes it a good variety for commercial orchards. One objection to the fruit, when grown for the fancy trade, is that the apples are slightly lopsided and do not pack nicely in box packings. For other styles of packing, however, this would be no particular objection. There is one thing about the York Imperial—it has been so thoroughly tested that it can be recommended with the certainty that it will not fail when the results are counted in the orchard. The fact that it has been thoroughly tried makes it a more desirable sort to plant than some of the newer introductions which are undoubtedly of better quality as far as fruit is concerned. The tree should come into bearing in from six to eight years.

Pryor Red. This is an old variety that has been very largely discarded owing to the fact that it is not usually a reliable cropper.

White Pippin. This is another old variety that has done well in some sections. It is rather a reliable cropper and may be depended on for some fruit practically every year. Being a yellow apple, it is not such a good variety as are some other sorts, but possibly a few trees should be in every orchard.

Akin Red. (N., C., S.) This large, red apple is one of the very best commercial varieties, but unfortunately is a very slow sort to come into bearing. The flesh is firm, juicy, slightly yellow in color and of a very good quality. The fruit keeps well in cold or ordinary storage. The trees tend to make more of an upright growth than do most varieties, and can therefore be planted closer together than are some other sorts. For this reason it will be possible to plant a lot of Akin Red and fill in the space between the Akin trees with some other variety, such as Wealthy or Yellow Transparent, which come into bearing very much earlier. The upright habit of growth is something of an objection to the variety, in as much as it makes the fruit harder to spray and harder to gather. The Akin Red usually does not come into bearing short of from ten to twelve years, often not for fifteen to eighteen years. After it once starts bearing, however, it is a regular cropper and may be depended on year after year.

Gano. (N., C., S.) There are several strains of this exceedingly valuable apple. Some strains appear to be almost worthless, while the best of them are as good as anything grown in the apple line. The numerous conflicting reports relative to this apple are due almost entirely to the fact that different strains of the apple have been planted. Where it is possible to insure a good strain of the Gano, I think no better commercial apple can be planted in Indiana. The trees are hardy, come into bearing early, are annual croppers, and comparatively free from insects and diseases. The fruit is handsome, large, and the trees are exceedingly productive. While the tree and the fruit is fully as hardy as the Ben Davis, it must not be confused with the Ben Davis in any way. Nurserymen often claim that the Gano is simply an improved Ben Davis. This is not true, if they are talking about the genuine Gano as grown in Missouri. Dr. G. C. Mason, at Oakland City, Indiana, has grown the Gano to perfection and regards it as one of his very best commercial varieties, and also one of the very best varieties for his own use, both as a dessert apple and for cooking. The apple keeps well and comes into bearing early.

Indiana Favorite. (N., C., S.) This is another excellent sort for the commercial orchard and it, as well, should be planted in every home orchard. The apple is yellow in color, striped with red and the flesh is crisp, mild and subacid in flavor. The fruit resembles the Vandevere Pippin to a certain extent, and keeps well in storage. The tree is hardy and is an almost annual bearer.

Ben Davis. (N., C., S.) This old reliable sort will do well in any section of the country, and has in the past been the most profitable commercial apple ever planted in American orchards. It comes into bearing very early and can be depended upon for a crop of fruit practically every year, being resistant to frost, insects and disease. In the age of its glory the Ben Davis was an excellent market fruit simply because of its unusual size and beauty. The public, however, has gradually become educated to the fact that the quality of the Ben Davis apple is certainly below grade. Personally I think that a good deal of the bad reputation given the Ben Davis apple has been caused through the fact that growers of the fruit have insisted upon putting the apples on the market in the fall of the year, before they were half ripened. The Ben Davis is undoubtedly one of the latest apples that we have and is distinctly a winter sort. It keeps not only in the winter, but well into the spring, even in ordinary storage. If the apples are allowed to remain on the tree as long as possible, gathered carefully, properly packed till spring, and put on the market when they are really ripe, the fruit would have quite a different reputation from what it has now. In the spring of the year there are few apples that are better for cooking than the Ben Davis. It bakes as well or better than some of the other standard winter sorts, and should be a profitable apple in spite of the bad reputation which it now has with apple consumers. As a matter of fact the people who really know the fruit do not object to it in the season of the year when it is really ripe. In some sections of the State the Ben Davis has not been doing well in the last few years. It is difficult to account for this, for in some of the orchards where failures have been marked the care of the trees has been all that could be desired. I believe that there should be a certain percentage of Ben Davis trees in all commercial orchards simply on account of the thorough reliability of the variety. I believe, however, that in most cases the tree can be profitably displaced by the Gano, which is fully as hardy and of far better quality. Five to eight years.

Lady Apple. This is a small apple about the size of a crabapple, and is of considerable beauty and of good quality. It is, however, merely a novelty and not a fruit to be considered seriously by any commercial planter. One tree in the home orchard might not be out of place, simply on account of the quality and beauty of the fruit.

Stayman Winesap. (N., C., S.) This variety, that has recently been introduced, will undoubtedly supersede the old Winesap almost entirely. The fruit is of fine quality and the tree outranks the old Winesap in every particular. It is a better shaped tree, better bearer, more reliable, and is growing fruit of much greater size. The fruit resembles the old Winesap to a certain extent, but is much larger and the quality of the fruit is much better. The fruit keeps well, packs well, and is an exceedingly profitable sort on the market. In planting a commercial orchard I would see that a large block of trees were planted in this variety. Six to eight years.

Jeniton (Ralls Janet). (C., S.) This is an old variety that originated in France and has proved to be an excellent sort for many of our American orchards. The fruit is of medium size, of a yellowish color, striped with dull red. The apples keep well and are sure bearers year after year, often producing enormous crops of fruit to the tree. Old trees, in some cases, do not seem to be as productive of good fruit as the young trees. This may be due, however, to the neglected condition in which the old trees are mostly found. The fruit is very subject to apple scab, and must be thoroughly sprayed in order to prevent this trouble. The trees are also liable to overbear, and it is frequently necessary to thin the fruit if the best grade of fruit is to be produced.

Ingram. (S.) This large red apple is a seedling of the Jeniton and is better than the Jeniton in some ways. The fruit is very much larger and of better keeping qualities than the old Jeniton, although the old Jeniton was about all that could be desired in that respect. Like its parent, the Ingram is inclined to overbear, and when this happens small fruit is unavoidably the result. In parts of Missouri this apple has been one of the most successful sorts, especially in off years for other varieties. The trees are hardy and resist frost to a wonderful degree. Dr. Mason, at Oakland City, Indiana, has grown the Ingram to perfection and regards it as one of his very best late varieties, the fruit keeping well into the spring. The Ingram is an excellent apple as regards quality, and is one of the very finest for cooking, especially for baking. The trees come into bearing in from five to seven years.

Delicious. This is one of the recently introduced apples, and as a general rule I do not believe that it is good policy to recommend for planting a fruit that has not been thoroughly tested in all sections of the State. There are comparatively few growers in Indiana who have ever tried the Delicious apple, but wherever it has fruited I understand that it has given entire satisfaction. Personally I have never seen an apple of the Delicious variety grown in Indiana, and cannot speak from experience on the matter of the success of this variety in our State. I have, however, seen a good many Delicious apples from other sections of the country, principally from the West, and I am very much impressed with the quality of this fruit. I do not know of any other apple that can compare with it in quality. The fruit has a peculiar quality that is very difficult to describe. It seems to me that the introducers of the apple have struck a peculiarly effective name in calling it the Delicious. The name certainly describes the quality of the fruit better than any other term that I could use. The Delicious apple is large, almost solid bright red, with a light golden tinge at the calyx end. It is characteristic of this apple, too, that there are four or five protuberances or lobes at the calyx end of the apple, giving the entire fruit somewhat the shape of the old "Sheepsnose" apple. This is, perhaps, one objection to the fruit, inasmuch as apples of this shape are difficult to pack in boxes such as are used for fancy packages, and this objection will no doubt tend to make it a less profitable sort for the fancy trade. I believe, however, that the apple is of sufficiently fine quality to warrant unusual care being taken with it in putting up the packages. Considering the prices that have obtained in recent years for our standard old varieties, I think that the Delicious will probably be able to command from 50 to 75 per cent. more than the best price that is realized for our standard varieties today. I can truthfully say that I have never seen any other apple that can possibly compare with it in quality. The habit of growth of the tree is somewhat objectionable. It grows a good deal on the order of the old Winesap, and the straggly branches do not make very satisfactory trees in the orchard. This seems to be the chief objection to the tree when commercially grown. In Gibson County there has been a good deal of trouble with the Delicious from blight. Dr. Mason has so far been unable to get the tree to grow on account of the blight attacking the trees shortly after they were planted. This may be a difficulty peculiar to his particular section. It is the only complaint that I have on record of the Delicious trees blighting. The introducers of the tree make exactly the opposite claim for their variety, saying that it is blight-proof and aphis-resistant. Their experience with the variety is, of course, much more extensive than mine, and I would not want my statement of the behavior of the tree in Gibson County to affect the planting of what seems to be an exceedingly valuable variety in other sections of the State. If I were planting an orchard myself I would not hestitate to plant a considerable block of this variety. I do not know how early the variety may be expected to come into bearing.

CRAB APPLES.

Whitney. (N., C., S.) This excellent little crab is almost too good to be termed a crab apple. It is very hardy and will do well almost any place in the State, and is certain of success in the northern section.

Florence. (N., C., S.) This is a very beautiful crab apple and is distinctly valuable, not only for its fruit, but as an ornamental tree, on account of its very beautiful blossoms. The tree is something of a dwarf grower and can be planted in a space that would not accommodate a large apple or a large crab tree. It is exceedingly hardy and comes into bearing very young.

Transcendent. This is an excellent crab, but unfortunately is apt to blight. I think that other varieties could be planted that would prove better both commercially and for home use.

Red Siberian. (N., C., S.) This hardy crab apple produces small fruit, yellow in color, red on one side. The tree is rapid growing and of good size and exceedingly productive. The fruit, however, does not begin to compare with other varieties of crab apples which may be planted. The Yellow Siberian has the same objections to it, though it is valuable from the fact that it is an early variety.

Martha. This is an excellent crab apple, of about the same season as the Yellow Siberian and of very much better quality. It is so mild in flavor that it can be used for eating just as it comes from the tree.

PLANNING THE ORCHARD.

The first point in planning the orchard is to decide on its location. Much of the future success of the establishment will depend on the care and judgment exercised at this time. A mistake made in locating the orchard is one which can never be remedied, and if a bad location is chosen it will act as a handicap as long as the ground is allowed to remain under fruit culture.

For the home orchard the principal thing which must be considered is the convenience of the owner. The orchard, of course, should be located near the house for several reasons. In the first place it will be easy of access in securing fruit for home use. It will be close to the buildings, so that the fruit will not have to be hauled a great distance; spray materials and spray pumps can be kept at the barn close to the orchard, thus making it easily tended. Another consideration in placing the home orchard close to the owner's building is that the fruit can be more easily watched at the time it is ripening. In some sections this is an important point.

As indicated under the discussion of "Soils," the soil of the orchard is really of secondary importance, as practically all of our Indiana soil is capable of growing good apples provided it is well drained.

On the average farm it is probable that the most economic location for the orchard would be on ground that is not so well adapted to some other crops. If there is any slightly rolling or hilly ground on the farm it can be more advantageously planted in trees than in any other kind of a crop. The roughest ground should, of course, not be used. The ground used for the orchard should be rolling, but should be level enough that it can be easily driven over with a wagon or a spray cart. Practically the same principles hold good in selecting the location of the commercial orchard.

The problem of the location of the commercial orchard, however, is greater than that of the home orchard, and more factors enter into a settlement of the question.

In the first place we must consider the accessibility of the location as regards the market, and must consider not only the distance from the market where the fruit is to be sold, but the railroad facilities as well. And in connection with this point it is always well to bear in mind that two railroads are better than one. The wagon road leading from the orchard to the railroad station should also be taken into consideration. The intervening country between the orchard and the railroad station must be of such a character that hauling to the station will not be too expensive. This calls up the question of good roads, to a certain extent, and also takes into consideration the hilly character of the land. Some of the Brown County land is admirably adapted to fruit growing, but it is not suitable for commercial orchards simply on this account. The exceedingly bad roads make it an almost impossible matter to get fruit to the railroad. In many cases these roads are so bad that no reasonable amount of work would put them in condition to haul fruit over.

A NEGLECTED BROWN COUNTY ORCHARD.

Showing badly formed trees, lack of cultivation, and hillsides too steep to be planted in orchard crops. Such hillsides should be utilized for the growing of forest trees.

The labor question must also be considered in selecting the site of the commercial orchard. A large amount of labor is frequently necessary in the orchard, and unless this labor can be had at a reasonable figure, and in sufficient quantities, it would be a doubtful venture to enter into the orchard business. The labor problem is one that is bothering farmers, not only all over Indiana, but all over America, today, and it is a serious question as to what we are going to do for labor on our American farms. You can go into any small town in Indiana today and find any number of loafers lying around the livery stables and the cigar stores who are not willing to go out into the country and work for two dollars a day. Many of these fellows are young men who came into the "city" from the farm and have failed to make good. They are capable of nothing better than day labor, and a very poor quality of day labor at that, but they are not willing to get out and do the hard work that is necessary on the farm. There is no question but that this idle class is growing, and that it is being augmented very largely from tho farming classes. If I were entering into a large commercial fruit project I think that I would very seriously consider the use of Swiss labor, if it is possible to obtain it, and I believe that it is possible. At any rate I am absolutely certain that one would be foolish to enter into any sort of a commercial venture without knowing that adequate labor would be available to handle the necessary work on the place. This, of course, is not true in all sections. There are many sections where good labor is available at reasonable prices. Such a location would be an attractive place in which to start an orchard or any other venture requiring labor. In a commercial orchard the value of the land must be considered, as well as the other points mentioned. This, of course, does not enter into the consideration of the home orchard, as the amount of land occupied is so small that the value is negligible. In the commercial orchard, however, the value of the land is a secondary consideration, as the ultimate value of the land will, in any event, be very much greater than the initial value.

Like the home orchard, the commercial orchard must be well drained and must be level enough to drive over at any place. This is an exceedingly important point and has been the source of failure in many orchards that have been planted in Indiana. It is a mistake to try to grow fruit commercially on ground that is too steep to readily drive over with a spray-wagon. This, of course, applies not only to going through the orchard with a spray-wagon, which is an important point, but also applies to the ease with which the fruit may be harvested.

After deciding the location of the orchard, the next thing is to decide on the varieties which are to be planted. It is probable that this is a question on which no two authorities will agree, but is one that must be settled by every planter for himself, and can only be settled by a thorough study of the varieties offered by the leading nurserymen of the country. The list of varieties contained in this report includes most of the valuable sorts for growing in this State. It is inadvisable to attempt to grow all of these varieties in any orchard, either for home use or for commercial purposes. The list is published simply as a guide to orchard planters throughout the State. I know that a guide of this sort is needed, and needed badly, by people who are thinking of going into the business of growing apples, and an inexperienced planter is very liable to be led astray with regard to the varieties which he plants.

I was very much amused last winter when a young man just out of college came to me to talk over the advisability of planting a commercial orchard in Indiana. I convinced him that it was a good commercial proposition, and, as he already had a leaning towards the apple industry he bought a farm and decided to plant a large part of it in orchard. We had a number of conversations regarding varieties, at which no definite agreement was reached. Some time afterward I met the young man and he told me that he intended to plant a large block of the Lady Apple. I asked him what his idea was in planting that particular variety. "Well," he said, "it is a good keeper, good quality, a very handsome apple, hardy, and a reasonable cropper." I admitted all these points in favor of the fruit, but asked him if he knew the size of the apple. He said he knew that it was a small apple, but its superlative beauty would make it a desirable fruit in spite of its small size. A few days later I had an opportunity to show him the catalogue of one of the leading American nurserymen and called his attention to the quotation regarding the Lady Apple. It follows: "A novel, dainty, small apple of uniform size, ... should be in all amateur collections." He, of course, saw at once that the apple was not a commercial possibility in any way.

As an example of a successful planting of a commercial orchard, I would like to refer again to the orchard of Dr. G. C. Mason, at Oakland City, Indiana. Dr. Mason has tried many varieties, but his commercial orchard is limited to the following:

- Jonathan.
- Gano.
- Stayman Winesap.
- Winter Banana.
- York Imperial.
- Wealthy.
- Grimes Golden (planted as a filler).

It will be noticed that this list does not contain any summer apples. This is not because Dr. Mason does not approve of summer apples, for he is now planting some. Summer apples, however, may readily be omitted from the commercial orchard entirely, but in many cases it would be wise to have varieties that will give a succession of crops throughout the season.

It will also be noticed in Dr. Mason's list that the Rome Beauty and the Delicious are both omitted. This is because the Rome Beauty has failed in Dr. Mason's particular experience. This does not condemn the variety for planting, even in his own neighborhood, and certainly not through the State. The Delicious is reported by Dr. Mason as blighting badly in his section, and for that reason he does not recommend that it be planted. From my personal experience throughout the State I would offer the following three theoretical lists of varieties for the south, central and northern parts of the State:

For the south section I would suggest the—

Gano.
Ingram.
Winter Banana.
York Imperial.
Stayman Winesap.
Jonathan.
Rome Beauty.
Grimes Golden.
Delicious.

These are the standard winter apples, and the varieties are given in the order of their importance as I consider them.

The summer apples for the southern part of the State that I regard as good commercial varieties are—

Early Harvest.
Yellow Transparent.
Chenango.
Duchess.
Wealthy.

The central section; winter varieties—

Stayman Winesap.
Banana.
Rome Beauty.
York Imperial.
Jonathan.
Grimes Golden.
Indiana Favorite.
Delicious.

Early varieties—

Early Harvest.
Red June.
Transparent.
Duchess.
Wealthy.

For the north section; winter varieties—

Stayman Winesap.
Banana.
York Imperial.
Jonathan.
Baldwin.
Northern Spy.
Delicious.

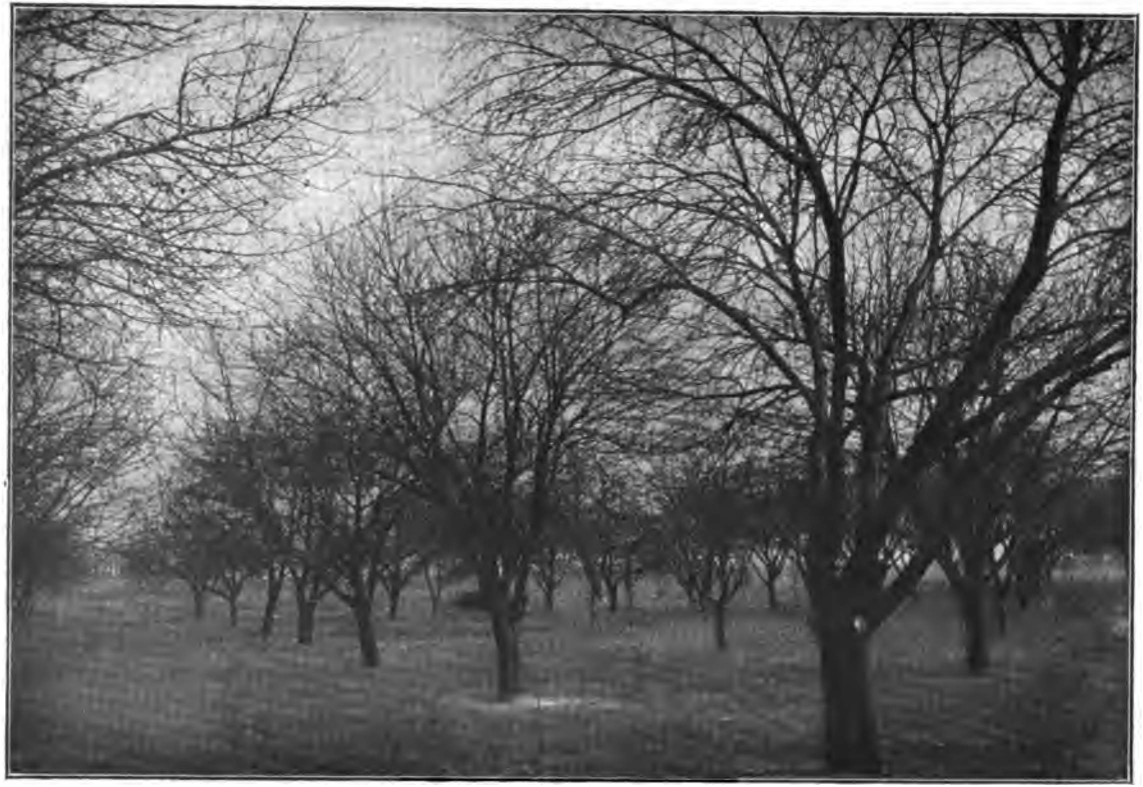
Early varieties—

Yellow Transparent.
Duchess.
Wealthy.

It will be noticed in all of the lists of winter varieties that I have placed the Delicious at the end of the list. This does not mean that I regard the Delicious as the poorest apple in the group, but simply that it has been tried less than any of the others. I think that it is worthy of trial in any section of the State to a very considerable extent.

It is probable that no list would meet with the ideals of any two planters. But I feel that the lists given are conservative and safe for their respective ranges. These lists, of course are given as guides for planting in *commercial* orchards. The varieties for the home orchard may include many sorts that are not profitable, but are desirable in other ways. For instance, I would plant a great many more early varieties in the home orchard than are given in the commercial list above. I would include the Chenango and the Red Astrachan in practically all home orchards, and possibly the Maiden Blush, and certainly the Rambo. The home orchard is not supposed to be run for profit, but is designed to supply the wants of the individual owner.

After selecting the varieties that are to be planted, it should next be decided how the orchard is to be laid out. In general there are two ways of laying out an orchard, known as the square plan and the triangular plan. The first, or the square system, is the old standard method of planting an orchard, the trees being planted at the four corners of the square and filler trees being placed in the center of the square. The distance at which the permanent trees should be planted is another question on which authorities differ. Nurserymen have for a long time contended that apple trees may be planted as close as twenty-eight or thirty feet. I do not regard this as a safe distance in permanent orchards. This is a distance that would be satisfactory for a few varieties, but for most of the large-growing standard varieties forty feet is not too much. I would advise planting all trees forty feet apart, with the exception of certain of the summer varieties, which in my list of varieties are mentioned as dwarf growers. The older planters in the State are beginning to realize this fact. You cannot find a twenty-year-old orchard in Indiana that has been planted with the trees thirty feet apart in which the trees are not crowded. Very often planters set their trees as close as twenty feet apart each way with the expectation of taking out the intervening trees when they begin to crowd. As a matter of fact they seldom have the moral courage to take out the necessary trees when they should be taken

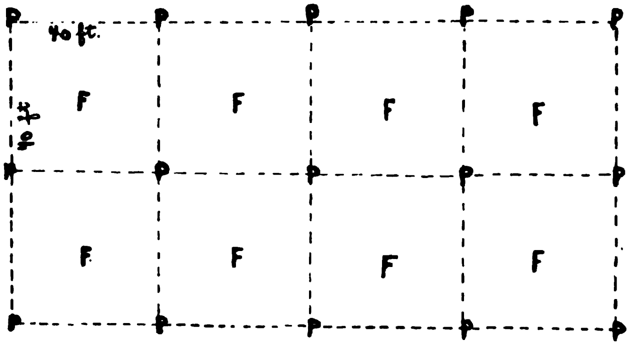


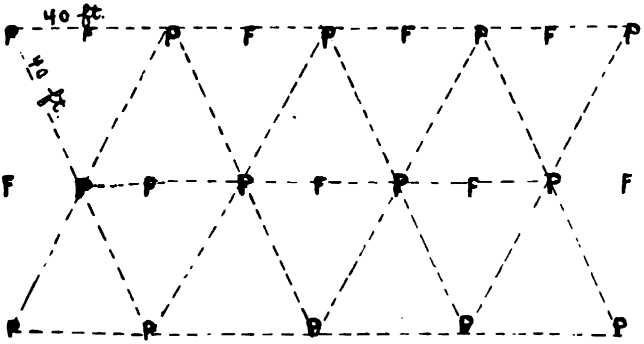
ORCHARD PLANTED TOO CLOSE.

Trees are "high headed."

out, and as a result the orchard is very seriously damaged if not ruined.

The accompanying diagram illustrates the planting of the square system and the proper provision for the filler trees:





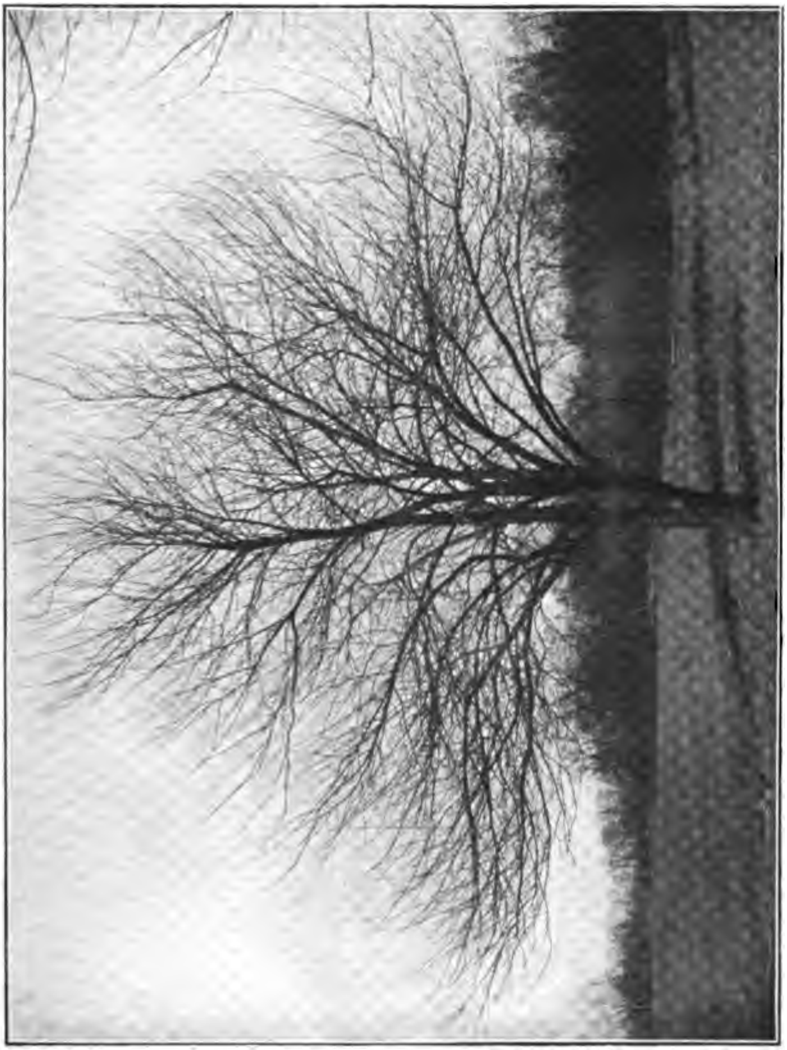
The triangle method of setting out an orchard is a new scheme that is advocated very largely by nurserymen, apparently for the reason that it allows more trees to be planted to the acre than with the old system. In this system the trees are planted at the three corners of an equilateral triangle. The accompanying diagram illustrates this scheme of planting better than any description. As stated before, it allows the planting of more trees to the acre, and also allows cultivation in three directions. It is doubtful if the three-way cultivation offers any special advantage.

The next point in planting the orchard is to select the stock to be planted. The trees should be one or two years old, but not over two years in any case. Wherever possible it is always advisable for the planter to go to the nursery personally and see the trees before they are taken from the ground. In this way he can be certain of more perfect stock than if he trusts to a shipment direct from the nursery. Where it is not possible to go to the nursery to make a personal selection of the trees, certain specifications should accompany every order, so that the proper stock may be secured. In case the bill of trees should not conform to the specifications of the planter he can then have recourse against the seller of the stock. Unless these specifications are included with the order it is doubtful if the planter would get very much satisfaction from the nurseryman. The one-year-old trees should stand at least thirty-six inches high, and should not be less than one-fourth of an inch in diameter. They should be smooth and straight in every case. The two-year-old trees should be at least five feet high, and should be not less than three-fourths of an inch in diameter, straight and smooth, as the one-year-old trees. There should be no dead branches, though a recently broken top is no detriment to the quality of the tree, as most of the top will be pruned away when the tree is planted. They should be root perfect—that is, there should be no broken roots, at least no large broken roots. Mechanical defects of the small roots may be passed by as of no consequence, as when the trees are planted they can be pruned off and no serious injury will result. But any breaks or torn places in the larger roots should be sufficient grounds for discarding the tree entirely. The presence of Woolly Aphis on the roots should be watched for, as should also Crown Gall and Hairy Root. These troubles are fully described in other parts of this report. It is unlawful to sell trees infested with these diseases, or with the insect mentioned, and all cases where such infested trees are received by planters should be called to the attention of this department. Since these troubles are in the roots of the trees, they are exceedingly hard to detect in our regular examination of the nurseries. The most expert nursery inspector will often not discover a slight case of Crown Gall or Hairy Root, and very frequently the work of the Root Aphis will be overlooked. The cooperation of the planter is asked in keeping these things in check in the nurseries.

TIMES OF YEAR TO PLANT.

The question of the best time of the year for setting the orchard is another one which has often been discussed, and one on which authorities do not always agree. It is generally admitted, however, that apple trees can be successfully planted at any time when the soil can be put in proper condition. Some years this may be best in the fall, and other years it may be best in the spring. It is probable that if equal care and attention is given to the planting of the trees there will be practically no difference in the result between the fall and spring planting. As a general rule I believe it is a little bit easier to get the soil in a good condition for working in the fall than it is in the spring, although this will vary with different seasons. Nurserymen vacillate in their recommendations regarding the time to plant, varying as they may have a good or bad season for the sale of trees. Should a nurseryman have an overstock for his fall delivery he is likely to advocate fall planting, and *vice versa*. The planter should remember, however, that as a general rule he can secure a better list of varieties in the fall of the year than he can in the spring. In the spring of the year the nurseryman's stock has been gone over for the fall trade, and often the best of it has been culled out. It is very frequently difficult to secure first-class stock of any sort in the spring of the year, unless the order has been placed the previous fall and the stock has been reserved. It is a common practice with nurserymen to dig all of their left-over stock in the fall of the year and place it in storage cellars until spring. I would not advocate the planting of such stock. I realize that in most cases stock which is properly stored will grow, but it cannot help suffering considerable shock from the long storage out of ground. The ideal way, if the trees are to be planted in the spring, would be to have the selection of stock made in the fall and leave the trees in the ground until they are needed the next spring. In this way the trees would be in perfect condition and would be out of the ground only a short time.

The soil of the orchard should be thoroughly plowed, in many cases with a sub-soil plow, and it should be worked as thoroughly as though a crop of corn was to be planted. A little extra care given to the setting of the trees will always well repay the planter. I know that in some cases the planters of large orchards have adopted some furrow method of planting, simply running a deep furrow through a prepared field and planting the trees at regular intervals in this furrow. I think this is very poor economy. In the Stevens pear orchard, near Salem, Indiana, we have one of the finest examples of hand planting I have ever known. The twelve thousand eight hundred pear trees were planted in one solid block, and out of the entire lot only two trees failed to grow. These trees were all planted by hand, the holes were carefully dug, and the trees set with care and diligence. In a large orchard there should be some scheme for a check-row in the trees. It is a good plan to have a long wire, with loops at regular intervals, and have this wire stretched across the field. Following along this wire a tree can be planted at each loop. When a row is completed the wire can be moved over and the next row of trees planted. When planting, a hole should be dug, throwing the top soil at one side and the bottom soil at another. The hole should be large enough to accommodate all of the roots without crowding, and the bottom of the hole should be loosened up so that the soil is not packed. All of the roots should be carefully trimmed wherever any broken places occur, and unusually long roots should be shortened. The roots are now placed in the hole, carefully arranged, and the top soil is first filled in and tramped down. It is exceedingly important that the first soil which is thrown into the hole be brought in *close contact with the roots.* The bottom soil is used to fill up the hole and part of it is tramped down. The last soil filled in, however, is not tramped, but a layer of loose pulverized soil is left on the surface of the ground near the tree. The lower soil is to be brought in contact with the roots so that they can at once start their growth. This they could not do if air spaces were left around them. The loose top soil is to retain moisture around the roots as long as possible by checking surface evaporation. The top soil should never be tramped down when the tree is planted. This is one of the most common mistakes of the amateur in planting trees. It may be argued by some that this method of tree planting is too tedious to employ in setting out a large orchard. I am satisfied, however, that the extra time and labor involved will be well repaid in the behavior of the trees after they are planted.



A NEGLECTED TREE BADLY IN NEED OF PRUNING.

PRUNING.

One of the most common defects in Indiana orchards is the shape of the tree, due either to too much pruning, or not enough. The art of pruning a fruit tree can be mastered only by long study and considerable experience. There are many common mistakes, most of which can be remedied and some of which can be avoided. I intend to take up most of them under the heading, "Bringing the Old Orchard Into Fruitfulness." At the present time I desire to discuss only the pruning necessary in the young, or recently planted, orchard.

The first pruning should be just after the trees are planted, if they are planted in the spring of the year. If they are planted in the fall, it is wise to refrain from any pruning until the following spring. Trees that are set in the fall are almost certain to winter kill for a few inches at the tips, and if the branches are pruned in the fall of the year this winter killing will often occur just as though the trees had not been pruned, necessitating more trimming the next spring. If one-year-old trees have been planted, they should be cut back to a single stalk of about two-thirds the length of the tree as it arrived from the nursery. If they are two-year-old trees, at least one-third of the tree should be cut away. It is in many cases good practice to trim the tree back to practically a single stalk, though this is not always necessary. It is this first pruning which will determine the height of the head of the tree, and this is one of the most important things to which the orchard planter should attend. It is absolutely necessary that the trees be headed low—anywhere from eighteen inches to three feet from the ground. This low heading gives a number of advantages in working the orchard when it reaches bearing size. Among these are to be numbered the ease with which the fruit can be sprayed and the convenience with which it can be gathered. High-headed trees are very common in Indiana orchards, and are a constant source of trouble to the owner, as it is almost impossible to do effective spraying work in orchards where the trees are headed high. The second pruning should be made at the end of the first summer's growth. If the growth has been vigorous this pruning will consist of shortening the longer branches and in removing any branches that are crossed. This work can be done at any time after the leaves are off the tree in the fall or before the buds open in the spring. Practically the same rules hold good for pruning each year thereafter. It is well for the man working in the orchard to remember that he is pruning his trees to obtain a definite result. It is wise for him to find just what results are going to be obtained by this trimming or pruning process. In the first place, it is desirable to keep the head of the tree low; and, in the second place, the branches must be grown so that they will accommodate the largest possible crop of fruit. There must be no crossed branches to rub one another and so weaken the trees and give entrance points for disease-producing fungi. The head of the tree must be kept open, so that ripening fruit will have free access to sunlight and air. If these points are borne constantly in mind the trimming of a tree becomes a far more simple proposition. Too often the orchard owner prunes his trees simply because he thinks they need pruning. As a general rule it will be found that the best time of the year for trimming the apple orchard is any time in the dormant season, preferably, however, in the late winter or early spring, after the ground has thawed and before the buds have opened. Fall pruning is often practiced, however, and frequently with good results.

Very often summer pruning is practiced on old orchards. As a general rule we may say that winter pruning produces wood growth, while summer pruning produces fruit. Summer pruning is usually made some time before the middle of the summer, that is, before the fruit buds have set. The careful orchardist will make a thorough study of his trees and will be able to tell just when this time comes. Every man owning an apple orchard should be able to detect the fruit buds as soon as they are formed, and yet I find many men growing apples in Indiana who have never been able to differentiate between the flower buds and the leaf buds. The theory of this pruning is that if the tree is cut back during the summer time it receives a sufficient shock to make it produce more fruit the following year, in order that it may yield sufficient seed to carry on the species.

After the young orchard is planted it must be protected during the first few years from the attack of rabbits and field mice. Both of these native animals are fond of the bark of the apple tree, and are frequently injurious to recently-planted trees. There are several common methods of preventing attack, and among the most effective is the practice of wrapping the trees with some sort of papering in the fall of the year and allowing it to remain on until the following season. Another practice is to paint the trees with some repellent to make the bark distasteful to the rabbits or mice. This practice is of doubtful value, and very often results in distinct injury to the tree. No grease of any sort should ever be used on fruit trees, for this or any other purpose, as many forms of grease or oil are liable to "strike in," as it is called, and injure the growing portions of the stem. I have seen trees that have been coated with axle grease in the fall of the year that were completely dead the next spring. Adjoining trees that were not so treated came through the winter in good shape. Any kind of a paper wrapping is effective against either rabbits or mice. The common newspaper is an excellent protection, though it is not lasting and may not go through even one winter in good condition. Heavy building paper is much better. Thin strips of veneer are sometimes used and where only a few trees are planted I have seen cornstalks tied around the small trees so as to form a complete protection to the trunk of the tree, and they serve the purpose admirably. Tar paper has often been used for this purpose, and makes an excellent protection, but should not be left on the trees through the summer. In one case that I know of in a Brown County orchard, tar paper was used as a tree protection, and the wrappings were left on from the fall of the year through the next summer. The hot sun of the summer evaporated the tar contained in the paper; this recondensed on the tree and resulted in considerable "scalding" of the trunk. Most of the trees, however, outgrew the difficulty, though a few of them were killed. Possibly those that were damaged may show bad results from the trouble later on. The paper wrappings should be removed from the tree as soon in the spring of the year as the danger from rabbits is over. This is usually as soon as the warm weather commences. The growth of the tree under the wrappings is liable to become very tender, and as a result the trees are likely to sun-scald when the wrapping is eventually removed. I believe that a good deal of this danger could be prevented by using as a protector a strip of burlap wrapped around the tree. This sort of a protection will not only prevent the rabbits and mice from bothering the tree, but it will also serve as a protection to the trunk of the tree during the summer months, and possibly avoid some of the injury known as the sun-scald. The porous nature of the burlap is also an advantage in its favor and allows free circulation of air and some sunlight to penetrate to the bark of the tree. In this way the bark tissues will not be of a tender nature and the burlap wrapping can be left on from one year to the next. It should last for several seasons. While the cost of burlap wrapping will be greater than that of the paper protector, the saving in labor replacing the paper wrapping each year should make up for the increased cost of the burlap.

When the young orchard is planted it should be cultivated just as though a crop of corn was going to be planted. Just as much care should be given to a crop of apple trees as is given to a crop of any of the grains. Farmers who plant trees sometimes wonder why their trees do not grow well when there is abundant evidence that the trees were thrifty when they grew in the nursery. They forget that the nurseryman was growing the trees with an eye to producing the most perfect tree possible. In order to do this it was necessary that he cultivate his crop just as thoroughly as the farmer would cultivate his crop of corn. There is no crop I know of that requires more care and attention, or more thorough cultivation, than a crop of trees. This will be found to be thoroughly illustrated in any well-kept orchard or nursery in Indiana. I realize that there are many fraudulent nurserymen, but I really believe that the general reputation of the nursery business would be better if the farmers who plant the trees would give them intelligent care after they are planted. After the young orchard is planted it should be thoroughly cultivated, and when I say cultivated I do not mean that a

A YOUNG ORCHARD IN SOUTHERN INDIANA WHICH IS UNDER PROPER CULTIVATION.

little circle of dirt should be scratched up around the trees. The entire area should be gone over and the soil kept thoroughly stirred. This will result, not only in the immediate growth of the tree, but will bring many soil elements into a condition where the trees will be able to use them when the roots have reached farther out into the field.

The cultivation the first few years should be *deep,* possibly with a heavy subsoil plow in most soils. This deep cultivation results in getting the roots at a lower level than they would ordinarily be. Surface cultivation, when the orchard is young, tends to draw the roots to the surface and places them in a position where they will be injured by cultivation later on in the life of the orchard. Many planters practice the system of cultivation whereby corn or some other crop is grown between the trees for the first two or three years. This is not an altogether bad practice, though I am not in favor of it if the best results are to be obtained. I realize, however, that an orchard is a "long-time investment," and that frequently something must be done to bring some returns from the land before the trees come into fruitage. In such a case the cultivation of the ground may be paid for and perhaps some profit yielded by growing a crop of corn between the rows of trees. It must be remembered, however, that no crop so completely exhausts the potash in the soil as does a crop of corn, and for this reason a potash fertilizer should be used on the orchard if corn is grown between the rows.

After three or four years the trees should be so thoroughly established in the soil that the roots will be permanently fixed in their positions, that is, they will be deep in the soil and not in a position to be seriously injured by shallow cultivation.

It is at this time that a permanent system of orchard cultivation should be adopted by the planter. One of the best plans is to cultivate the orchard with shallow cultivation each season until early summer, then sow some cover crop like cowpeas, buckwheat, clover or some grain. The exact cover crop for each location will have to be determined for that place. No one cover crop will answer for all locations, and probably no one cover crop should be repeated too many years in succession. The Legumes, to which the cowpeas, soybeans, clover, and similar plants, belong, all possess a certain function in relation to the soil. These plants, members of the bean family, possess the faculty of fixing the nitrogen of the air in such a form that it may be utilized in the soil. This is done by the action of a peculiar bacteria which causes slight galls on the roots of the plants. These galls may be found on the roots of any member of the clover family and it is due to their decomposition that nitrogen is added to the soil and made available for such crops as may be grown in that soil in the future. Rye, buckwheat, etc., do not possess this faculty of adding nitrogen to the soil. They are valuable in many soils, however, as they add humus or leaf mould to the soils which lack this character. They are consequently valuable on sandy or clay soils. The native weeds which occur in all soils are not bad cover crops. Very frequently an orchard is quite a success where the cultivation does not involve the planting of any special cover crop at all, but allows the native weeds to grow up and form such a crop. The repeated growth and turning under of these native weeds adds humus to the soil and makes many of the mineral elements of the soil available for plant use. This is especially true in making available nonavailable potash. Potash occurs in our soil as a decomposed granite rock. Most of the Indiana soil has an abundance of it, but it is not always available. The available part is frequently exhausted by successive crops of corn, potatoes, etc., making the soil deficient in available potash. The growth of a cover crop, or allowing an orchard to lie fallow in weeds for a year, or a few years, breaks some of this granite rock down into such form that it may be utilized by the plants which grow on the soil. I have seen some very remarkable examples of just how this process works.

North of Indianapolis is a valuable farm, most of which consists of what is known as bottom land lying along a stream. This ground was notably rich, and for many years it was planted in corn and other grains. After many seasons of hard work this ground became exhausted and the last crop of corn that was produced on it was not only poor in quality, but was very small in quantity. The city had, at that time, grown out to the location of this farm and for several years no crops were grown on it, the farm simply standing in weeds in an uncultivated condition. After four or five years of neglect the successive crops of weeds had yielded enough available potash that a crop of corn planted on the soil produced an average of eighty bushels to the acre. Cover crops in the orchard work just this way. The plants grown do not take anything *out* of the soil, but they break up the soil so that the sunlight, air and frost can decompose the particles which form the soil and render the different chemical elements available for the use of apple trees. This is one of the greatest functions of the cover crop in the orchard.

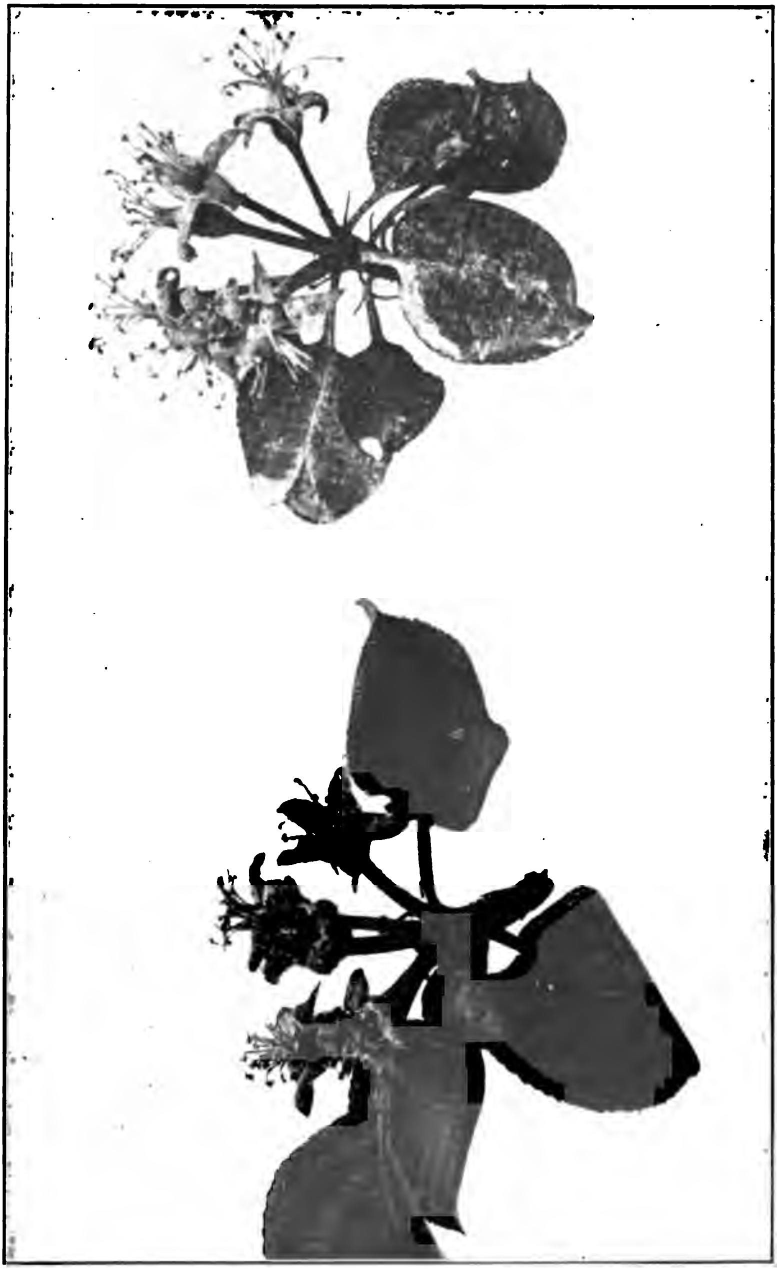
FRUIT.

The real work of the horticulturist comes when the orchard begins to bear. At this time, also, comes the test of the thoroughness of the preparatory work. The thoroughness of this work will determine in a very large part the success of a planting. However, the growing of perfect apples, and the placing of them on the market, requires a very decided degree of skill, extreme thoroughness, and constant watchfulness. Each year the fruit must be sprayed, harvested, and marketed, and each of these three operations is a study in itself. No lazy man should ever go into the fruit business, for it is a work that requires, above any other branch of agriculture, the utmost diligence. The fruit-grower must also study his work and have an open mind to accept new things as they are presented to him. The success of the orchard men in the West, it is said, has been due largely to the fact that most of them did not know anything about apple-growing before they went west. They were not handicapped by any of the eastern theories and went west with unbiased minds and were willing to take up with the best methods of cultivation known at the present time. The diligent following of these methods has wrought the phenomenal success of the apple-growers in the western districts.

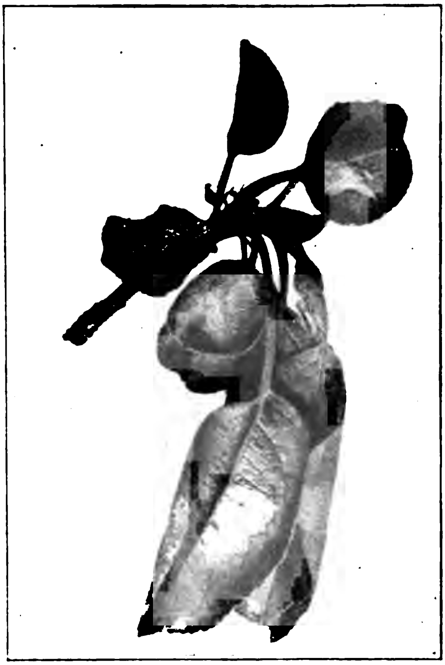
SPRAYING.

This is another question in orchard management on which authorities differ very decidedly. Moreover, there is considerable ground for difference on a question of this sort, as one system of spraying will yield results in one locality and in the hands of one operator, and the same system in another locality, or in the hands of another operator, will yield poor results. In a general way the eastern and western systems of fruit culture are radically different.

The eastern system contemplates the use of a low-pressure mist spray and applies three or four, or even more sprayings each season. The western system uses a coarse high-power spray and applies only one spraying each year.



SPRAY JUST AFTER THE PETALS HAVE FALLEN AND BEFORE THE CALYX LOBES CLOSE.



Apples too late to spray.
Calyx lobes closed.

Personally, I am inclined to favor the eastern method of insect and disease control, not but that I realize that the western system produces very excellent results throughout the West. Our conditions, however, are not western conditions. We must remember that most of the orchards of the West are young orchards that have been carefully tended and thoroughly sprayed ever since they were planted. Consequently the diseases which bother the fruit throughout the West are far less prevalent than they are in our section. We have many old orchards scattered all over the country that are an abundant source of infection to our fruit; consequently there is a much greater chance of our fruit being infected, and we must accordingly be more watchful of it than we would be if the section was new and all the orchards had been carefully sprayed from the time they were planted.

I think that in most localities in Indiana there might be a compromise between the eastern and the western methods. I am very much in favor of a high-power spray for the control of the Codling Moth. I am satisfied that such a spray will be more effective for the control of this insect than is the mist spray which is used at the present time. In some sections of the State, and in some seasons, I believe that the western method might be adopted in its entirety. I feel that there are some places where a single spraying will give almost as good results as though the trees were sprayed half a dozen times. The planter must consider the results he is getting from his spraying work, and unless his four or five sprayings are going to yield him a commercial profit they would, of course, not be advisable. In most cases I suppose the greatest benefit will be derived from the spraying made immediately after the blossoms fall. This is the principal spraying for the control of the Codling Moth, and I believe that it will also result in a very complete control of most fungous diseases. The orchardist must adopt the system of spraying that will yield him the greatest profit in dollars and cents, and not the one that will absolutely control some particular fungous disease. If the loss from some fungous disease amounts to less than it would cost to prevent this loss, then, of course, it is better to simply accept it and make the best of matters. This is common business which is apparent to everyone. I would suggest the following spray calendar for most sections of the State. This calendar is a combination of theoretical spray systems and the practical working out of theory in the field.

First Spraying.—This should come before the flower-buds open in the spring of the year. It should be made with a fungicide to which has been added a proper amount of arsenate of lead. The question of fungicides will be discussed in another section of the report. This first spraying is made principally for the control of the Apple Scab. The addition of arsenate of lead is intended to head off the work of any leaf-eating insects that may appear early in the spring. Among these insects are to be numbered the Bud Moth, and the Spring Canker Worm, both of which may be found in Indiana. This spraying does not prevent the Apple Scab on the fruit, but prevents it to a certain extent on the leaves. As will be stated elsewhere in the report, the Apple Scab is an injurious disease found not only on the fruit, but on the leaves as well. I doubt very much if this first spraying is of sufficient value to justify its use. I think that nearly all of the good which this first spraying is said to accomplish will be accomplished by what is ordinarily termed the second spraying, and for my part I think I would omit this first spraying entirely, and would perhaps use the saving in cost on later treatments in the orchard.

Second Spraying.—This should be made just after the petals fall from the flowers and before the lobes of the calyx have time to close or curl in. It will be noticed when the petals fall from the flower of the apple that the lobes of the calyx stand open and the calyx cup is in good condition to be filled with any poison which is sprayed upon it. This spraying is made chiefly for the control of the Codling Moth. I believe, too, that this spraying will do more for the control of the Apple Scab than anything else would do. The first brood of the Codling Moth enters the apple through the calyx end, and the object of this spraying is to fill the calyx cup with poison so that the larvae of the Codling Moth (the apple worm) will be killed before it can enter the apple. Thus will be seen the reason for getting the poison on the trees before the calyx lobes have closed in.

Third Spraying.—This spraying should be made about ten days or two weeks after the second spraying. This will be just about the time when the calyx lobes are closing. If possible this spraying should be made before the calyx lobes have entirely closed. This spraying is made to supplement the second spraying, and is made for the same purpose as the second spraying.

Fourth Spraying.—The fourth spraying is applied at the time when the second brood of the Codling Moth appears. This time can be determined only by observation in the orchard, as the moths will not appear any two years at exactly the same date. The moths of the second brood should be watched for and all infested apples should be destroyed. The worms which we find in our apples in storage are the larvæ of the second brood of moths. In some sections of the State additional sprayings will have to be made for the control of Bitter Rot, Black Rot, and Apple Blotch. Occasionally, in some localities, additional sprayings will have to be made for other diseases.

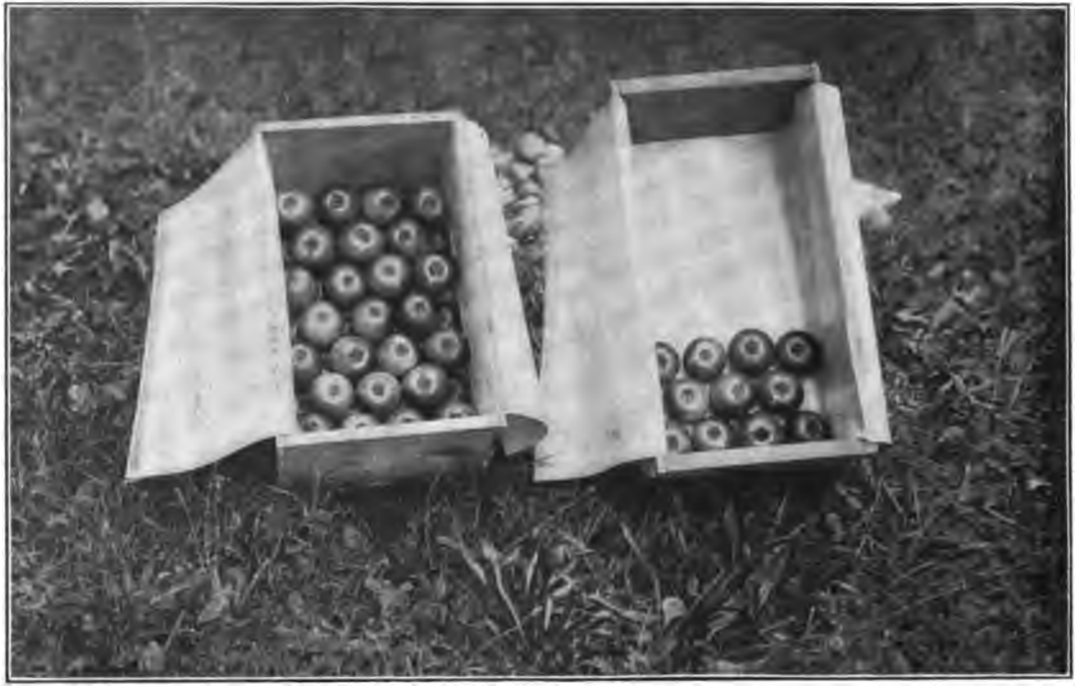
I believe, however, that if an orchard is sprayed by some such system as suggested in the previous outline there will be comparative freedom from fruit diseases. Successive sprayings will, of course, mean less and less trouble from year to year. The well-sprayed orchard requires less spraying than one that has never been sprayed or which is poorly sprayed. The one thing that must be constantly borne in mind in spraying the orchard is that the work must be thoroughly done. This holds true whether one spraying is applied, or a dozen. As a matter of fact I would rather risk an orchard that was sprayed once, and sprayed thoroughly, than one that was sprayed a dozen times with indifferent attention. Most of the failures that have been recorded in the work of orchard-spraying have been due to a lack of thoroughness on the part of the operator. Thorough spraying, of course, takes more time and costs more money, but it well repays the additional effort. Poor spraying might as well not be done at all, as it is an increased expense in the orchard and produces such indifferent results that it cannot be credited with any special advantage in orchard practice.

HARVESTING.

This is one of the most important parts of the orchard season, and is a feature of orchard work which must be given careful attention if the fruit is going to bring the best price on the market. Many growers are in the habit of selling their crops just as they hang on the trees and depending on the commission men who buy the fruit to harvest it and pack it. This never results in any very great credit to the owner of the fruit, and certainly does not give him the advantage of the best market prices. Neither is the crop handled with a view to bringing the greatest possible returns to the owner. There are too many cases on record where professional packing of this sort has been dishonest and has resulted in discredit to the orchard owner.

Two or three years ago I was impressed with the excellent crop of Kiefer pears in a certain orchard in southern Indiana. After returning to Indianapolis I requested the manager that I be sent a barrel of the pears from a certain section of the orchard where I knew they were of large size and good quality. In due time I received the fruit, with an explanation from the manager of the orchard that the entire crop had been sold and was being packed when my letter was received. The packing was done by the buyer of the fruit—a Cincinnati commission merchant. When I examined the pears I was very much pleased with the appearance of the barrel when the head was taken out, but was very much disappointed as I got deeper into the fruit. The farther I went the worse the pears were, until the fruit at the bottom of the package was absolutely unfit for use. I was at a loss to account for such extremely poor fruit from that particular orchard. I did not think it was possible to secure so many runty and rotten pears from the crop I had seen on the trees only a short time before. The secret of it was that the packer desired to use everything in the shape of a pear that was growing in the orchard, and to do this they were using the culled stuff, heading it up with the first-class fruit, and labeling the barrel as "fancy stock."

It is just such bad packing as this that has gained an ill reputation for our eastern fruit. The entire scheme seems to have been to sell the poorest stuff that was grown, and the small percentage of good fruit was used as a bait in order to do this. The orchard owner should arrange to harvest and market his own fruit, wherever



STANDARD AND SPECIAL SIZE APPLE BOXES.

Showing the method of starting what is known as the off-set pack.

possible. The owner of the property should give his personal attention to this work, as it is the culmination of a long season's effort and should be given careful attention. The apples should, in every case, be hand-picked, and both the fruit and the stem should be gathered. The apples should not be jerked off the tree so as to sever the stem from the fruit, as this gives excellent entrance places for rot-causing fungi. The fruit should be gathered in baskets or in bags and should be stored in the orchard in shallow piles on dry ground so as not to bruise the fruit, and so that it will not become wet from the soil. If it is necessary to leave the fruit in the orchard over night, it should be covered with canvas, so that there will be no danger from frost or dew. Such a protection, however, should be understood to be merely temporary, as the fruit should be packed and gotten out of the orchard just as soon as possible.

The fruit should be packed in boxes, if it is of good enough grade to be termed "fancy," and there is not much reason for growing any other grade of fruit. There are several reasons in favor of the box as a package for apples as against the old eastern package of bushel baskets or barrels. The bushel basket or the barrel does not make so attractive a package, and the barrel is a little large for the average home consumer. Many people would buy a box of apples who would not think of buying as many as a barrel. Then, too, the fruit packs better in the boxes and can be shipped longer distances, and will keep much better than it will in barrels or baskets. There is also much less waste room if the fruit is stored in boxes than in barrels or baskets. The boxes can be packed much closer together than can the rounded packages. Eastern dealers, for a number of years, have been arguing against the box as a package for eastern apples, but their arguments do not seem to hold together. If we can grow the same quality of fruit that is grown in the West, there is no reason why we should not pack it as well as it is packed in the West, and get just as good, or possibly a better price for it than the western fruit will bring. It is certain, however, that we will not get the fancy price for our fruit as long as we continue to pack it in unattractive forms and in this dishonest fashion.

The eastern barrel packings are notably in bad repute on account of the long prevailing dishonesty of the packers. I have mentioned the dishonesty of the professional packer, but the same conditions seem to hold true with many of the large growers of apples who pack their own fruit, so that often the commission man who buys fruit packed by the growers is deceived as to the condition of the fruit which he buys.

As a matter of business, western growers will not sell bad apples at any price. This reputation for quality has enabled them to command the very best market for apples in the world, and the prices they receive are the highest prices that have ever been paid for this fruit. We will never compete with the western growers in the markets of the world until we adopt western methods of packing. This does not mean merely the adoption of the box as a package, but the adoption of the honest policy that has prevailed among the western packers. The box packages are not merely faced with good fruit, but they are *good fruit all the way through.*

In the Hood River district of Oregon the growers have banded together into an association called the Hood River Apple Growers' Union. This union looks after the packing and selling of all fruit grown by the members. The following circulars are sent out by this organization, and show something of the care and attention which fruit packing receives in the West:

1. *Get everything* ready for packers as follows: Packing house, boxes, paper, packing table, nailing machine, nails, etc. Notify the office or the field inspector when you are ready for packing. The field inspector will then call on you and, if in his judgment the job is ready for the packers, he will arrange to put packers to work; if not, he will advise you how to proceed.

2. *Picking.* Do not allow pickers to pull off the fruit spurs, or bruise apples by dropping them into buckets or boxes. Apples should be placed in baskets or boxes and not dropped in or poured in. The stems of the apples should not be broken off. Haul the apples from the orchard to the packing house daily; do not allow them to stand in the orchard in the sun.

3. *Wiping and Sorting.* Apples heavily coated with dirt or spray must be wiped. Do not polish them. In sorting keep the fancy grades in boxes by themselves, the choice grade by themselves and the culls separate. Put four tier apples and larger together, and four and one-half tier and smaller together. Fancy Spitzenbergs should always be graded for color, 70 per cent. or more good red color. Keep the light Spitzenbergs separate from the red ones. Special advice will be given on other red varieties for color as sold.

4. *The Growers and Packers will be held equally responsible for the quality of the apples.* The grower is required to do all the sorting. If the apples are not satisfactory for *quality* upon final inspection at our warehouse, they will be set aside, the grower notified, and a special arrangement effected between the grower and the manager as to the dispo-

sition of the fruit. If it is decided to repack, the repacking will be done at the grower's individual expense. If the apples are to be shipped without repacking, they will be shipped in the next lower grade, or if too poor for the second grade, they will be shipped in the grade to which they properly belong. For instance, if packed for Fancy and rejected, they may be handled as Choice, if good enough; if not, they will be consigned to a local market for what they will bring.

5. *The packing house* should be arranged to let in plenty of light and keep out the wind. Provide sufficient lamplight for late in the afternoon, as it gets dark early.

6. *Packing tables.* Each grower should have one packing table, and more if needed.

7. *Paper.* Get plenty of paper early in the season. Paper for sale at the Union warehouse in town.

8. *Boxes.* Have a sufficient number of them on hand. *Keep them clean.* Do not pack fruit in dirty boxes. Buyers will not receive dirty boxes and the Union will not accept them.

9. *Apples on packing table.* Growers are expected to keep the packing tables properly filled for packers.

10. *Piling loose boxes of apples.* Do not fill boxes too full of loose apples for piling in your warehouse, or the apples will be bruised by the next box placed on top. If boxes should be too full, either take out some or place cleats between the boxes. No box should be placed on top of a box of apples so full as to cause pressure upon the apples in the under box.

11. *Piling packed boxes of apples without cover.* Keep the packed boxes out of the way of the packers, and do not under any circumstances allow the packers to pile a box of packed apples on top of a box already packed, and waiting for the cover. This will certainly bruise the apples, and may cause you loss when the pack is inspected at the Union warehouse. The Union can not accept apples that show bruises, no matter how caused.

12. *Piling and loading.* After covers are nailed on always pile boxes of apples on the sides, and load into wagons on the sides. Do not pile boxes of apples into the wagons by standing them on the ends. This doubles the risk of bruising when hauling by increasing the weight on the apples in the under end and settles the apples in the box, making an empty space in the top end, and the pack may be rejected for a loose pack. Packers will not be held responsible for loose packs when the apples come to the warehouse loaded in this way. *Always pile boxes of packed apples on the side and load them in the wagon the same way.*

13. *Grower's number and name.* Each grower is required to put his number on each box with a rubber stamp, in the upper right hand corner of the end. The numbers will be supplied by the Union. The State law requires the grower to put his name and postoffice address with a rubber stamp. You can order these stamps of the Union or at any stationery store.

14. *Name of variety and number of apples.* The grower will put on with a rubber stamp the name of the variety of apples in the center of the box near the top and the packer will put on with a rubber stamp the number of apples contained in the box just above the name of the variety. Be sure and do this right. All stamping must be done on one end of the box.

15. *Hauling.* Haul on springs, and use a wagon covered to keep off the dust and rain. Pile the boxes on the side. Haul as soon as packed. Don't keep them unless so advised.

16. *Nailing.* Use four nails on the sides, four on tops and four on bottoms. The best nail is 0 5-penny barbed or cement coated nail. Please no not use any other.

17. *Stencil.* Growers must supply themselves with the necessary stencils, viz.: names of their different varieties of apples, and also with the several size numbers of apples in the box, and such stencils as top, fancy, choice, etc. All of which may be procured at the Union at a very trifling cost.

18. *Growers must not make any* payments direct to the packers, but must sign packers' orders on the Apple Growers' Union for the payment of packers' orders.

19. *The buyer* will be requested to report the stencil number and name of the grower on all apples which are deemed not up to the contract of sale, and shall make sale of these apples and report the same separately, and the grower shall be given credit only for what his apples will bring in case the same are not up to the sale contract guaranteed.

GRADING RULES.

Fancy Grade. This grade consists of perfect apples only. The apples must be free from worm holes, stings, scale, fungus, scab, rust or any other disease, and free from all insect pests, decay or injuries. They must be free from bruises and limb rust, and the skin around the stem must not be broken. All apples must be clean, fully matured, not deformed and must have a healthy color. Spitzenbergs must have 70 per cent. or more of good red color. All red apples must be a good color.

Choice Grades. This grade consists of apples a little below fancy and includes such apples as are not perfect. These apples must be good apples, not culls. No apples with worm holes or broken skins will be accepted. Limb rubs must not be larger than a ten-cent piece. Only two stings will be allowed and no stings will be permitted where the skin of the apple is broken. No apples will be accepted if infested with San Jose scale, dry rot, or which show an open or a black bruise. Apples showing fungus will not be permitted where the spot is larger than a twenty-five-cent piece.

It will be necessary for the growers to see that the number of apples in the box is stenciled on both ends of the box, for the reason that the buyers desire the stenciled number of the apples in the box on the Fancy label, which is pasted on the end of the box, so that when the boxes are piled in the warehouse with the Fancy label end of the box showing to the trade, the number of apples in the box can be ascertained without being obliged to turn the boxes around.

Packers will be paid six cents per box for all sizes of apples, and also be allowed six cents per box for sorting off the packing table the apples not belonging to the grade which they are packing.

Packers shall not receive payment for their services until the apples packed by them shall have passed inspection at the receiving warehouse.

When the apples upon the packing table are not properly graded the packer shall immediately notify the field inspector, and the field inspector shall examine the same as soon as possible and require the grower to resort the apples for the packer, or shall pay the packer for sorting them, and if the same is not done by the grower, the field inspector shall withdraw the packer and place him at some other orchard.

The field inspectors must cover their respective territories and advise and consult with the apple growers as often as possible, giving them instructions for the correct way of sorting the apples.

Packers must not permit the growers to influence them to put off-grade apples into the pack, but should always bear in mind that a single bad apple may be the cause of having the pack held up by the inspector, and thus lose their packing wages.

RULES AND REGULATIONS FOR PACKERS AND GROWERS.

1. Each packer, before beginning work, must have his name registered at the office of the Union, and receive a rubber stamp free. He shall be required to stamp each box of packed apples at the lower left-hand corner with his official stamp.

2. Every packer must put up a first-class pack.

3. When a box is packed the packer shall stamp with a rubber stamp upon the end of the box in the center near the top the exact number of apples the box contains.

4. Each box of apples must be packed with about a three-fourths inch swell in the middle of top and bottom, but no box should be packed so high that it will be necessary to cleat the box before nailing on the lid. A swell on the box, however, does not mean necessarily a tight pack; the apples must be tight from side to side and from end to end. The Union wants a tight pack.

5. Packers will be furnished meals by the growers without cost, or allowed seventy-five cents per day by the grower for board, but must make necessary arrangements for bedding. The grower will furnish bed and mattress.

6. Packers are required to pack apples only properly wiped and sorted. If, in your opinion, the fruit should seem to be running poor grade for the pack you are putting up, notify the field inspector or the office at once. Remember you are held mutually responsible with the grower for the quality of your pack.

7. Each packer must set off his box when packed. Do not set a box of packed apples on top of another box of packed apples which has no

cover. This will bruise those in the under box. Be very careful about this.

8. The packers are all under the supervision of the field inspector, who may dismiss any packer for cause.

9. All packers must refrain from smoking on the premises of any grower against his wishes. Failure to do so will result in dismissal.

Special. The Union wants a *tight* pack of *good apples.* Don't jam the apples in and bruise them, but be sure to fill the box solid full in all directions, up and down, sideways and endways. Don't pack slack; pack full and tight.

Sizes. Four-tier apples include nothing smaller than 128 size; 144 size is special; 4½-tier includes 150 to 175 size; 5-tier includes 185 to 225 size.

Packers will be paid six cents per box for all sizes of apples, and also allowed six cents per box for sorting off the packing tables apples which do not belong in the grade which they are packing.

Packers shall not receive payment for their services until the apples packed by them shall have passed inspection at the receiving warehouse.

When the apples upon the packing table are not properly graded the packer shall immediately notify the field inspector, and the field inspector shall examine the same as soon as possible, and require the growers to resort the apples for the packer, or shall pay the packer for sorting them, and if the same is not done by the grower, the field inspector shall withdraw the packer and place him at some other orchard.

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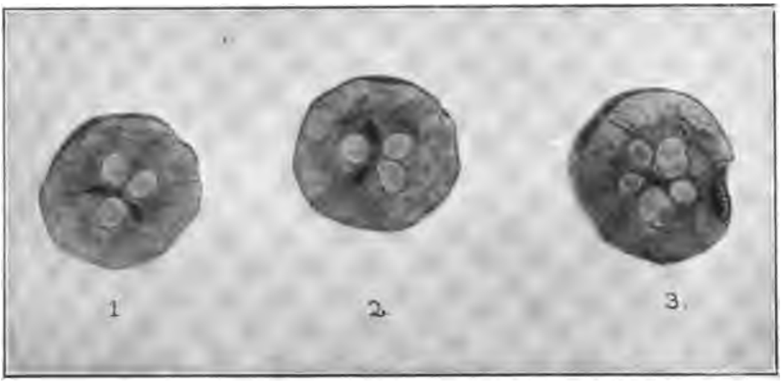
Packers must not permit the growers to influence them to put off-grade apples into the pack, but should always bear in mind that a single bad apple may be the cause of having the pack held up by the inspector, and thus lose their packing wages.

POLLENATION OF THE APPLE.

This is a subject which every planter of apples would do well to study thoroughly before deciding on the varieties he is going to plant. It is well known that many varieties of apples are not fertilized with their own pollen, but must receive pollen from the flowers of some other sort.

In the spring of 1909, C. I. Lewis and T. V. Vinson, of the Oregon Experiment Station, published a bulletin on the pollenation of the apple, and in it there is much data of value to the apple-grower. I am publishing the following list of self-sterile varieties obtained from this bulletin:

Autumn Sweet.
Arkansas Black.
Bietigheimer.
Bellflower.
Bottle Greening.
Canada Sweet.
Canada Reinette.
Gano.
Green Sweet.
Delaware.
Domine.
Dutch Mignonne.
Ewalt.
Early Strawberry.
Fallawater.
Great Bearer.
Gravenstein.
Golden Sweet.
Hoover's Red.
Haas.
Holland Pippin.
Holland Beauty.
Hydes Keeper.
Hanwell Sour.
Jonathan.
King.
Limber Twig.
May.
Melon.
McMahon White.



ONE AND TWO—IMPERFECT FERTILIZATION.
THREE—ALL SEEDS PERFECTLY FERTILIZED.

Mammoth Black Twig.
Melon Sweet.
Munson's Sweet.
Creole Beauty.
Maiden Blush.
Missouri Pippin.
Ortly.
Paradise Sweet.
Pewaukee.
Red Golden Pippin.
Red-Cheeked Pippin.
Romanite.
Rome Beauty.
Jeniton.
Rhode Island Greening.
Sweet Bough.
St. Lawrence.
Summer Queen.
Summer Pearmain.
Seel's Red.
Talman Sweet.
Transcendent Crab.
Trumbull Sweet.
Twenty Ounce.
Western Beauty.
Wealthy.
Winesap.
York Imperial.

The following varieties are found to be self-fertile:

Baldwin.
Bailey Sweet.
Bethlehemite.
Colvert.
Fall Wine.
Grimes Golden.
Keswick Codlin.
Longfellow.
Oldenberg.
Pumpkin Russett.
Scott's Winter.
Shiawassee.
Washington.
White Pippin.
Yellow Newtown.

The following varieties were found to be partially self-fertile:

Ben Davis.
Canada Red.
Fall Jeniton.
Jewett's Red.
Mann.
Willow Twig.
Pryor's Red.
Rambo.
Starke.
Spitzenberg.
Wagner.
Whitney's Crab.
Yellow Transparent.

These lists include many varieties that are not recommended for Indiana, either for commercial or for home planting, but the lists are interesting and furnish valuable information for the planter of the apples. None of the varieties mentioned in the first lists should be planted in solid blocks without other varieties near for pollenizing. The Grimes Golden has been found to be a strong pollenizing sort for other varieties and this makes it a valuable variety to plant for this feature. It is an old saying among fruit growers that when the petals rain off it will be a poor fruit year, but that when they blow off it will be a good fruit year. This really holds true, although many of the men who make the statement do not have any idea why it holds true. The reason simply is that in years when the bloom blows off it means that the weather is such that bees and other insects can fly about from tree to tree and carry the pollen from one tree to another, thus fertilizing the fruit as it should be fertilized—while in wet years they are unable to fly, and the pollenation is deficient.

The last two years have been notable for their damp, wet springs, and consequently much of the fruit over the State has been badly fertilized. During the last two seasons this has been one of the chief defects of Indiana fruit wherever any fruit has set. I have been much interested in the condition of the fruit in the orchard owned by George S. Demuth, chief of the Division of Apiary Inspection in this office. Mr. Demuth has about two hundred colonies of bees in his orchard, and the orchard is merely a secondary investment and is really only a repository for the apiary.

His bees are located among the apple trees where they have easy access to the blooms. If they have an hour of sunshine the bees will get out and be all over the trees during the blooming season, while orchards half a mile or a mile away have very few bees in them. During the last two years this orchard has yielded an abundant crop of fruit, and practically every piece of fruit was perfectly fertilized. The adjoining orchards show much less fruit and all of it was badly fertilized, as was shown by its imperfect development throughout the season. It has been proven that insects are the principal means of carrying pollen from one flower to another. The wind does very little work of this sort with the apple. The pollen is heavy and is not easily blown by the wind.

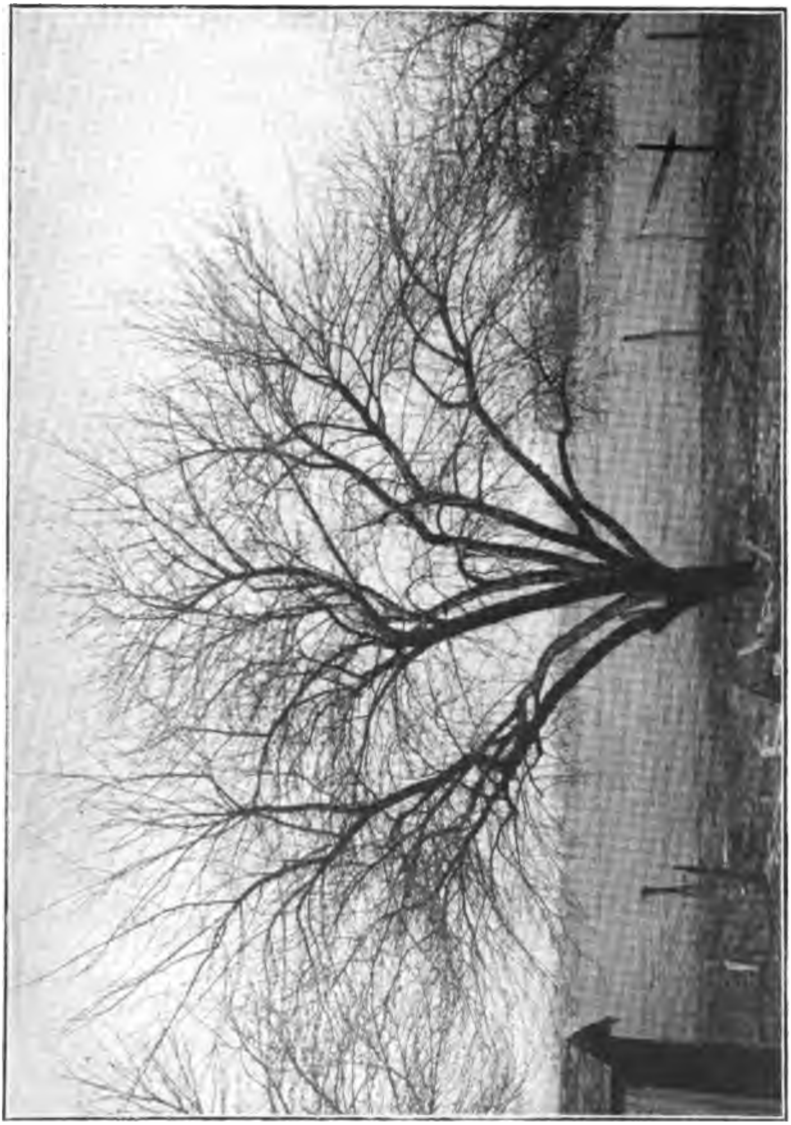
Of all insects the bee makes the best carriers of pollen for several reasons. In the first place, bees winter over in large numbers and are ready at the first sign of warm weather to venture forth and act as pollen carriers. In the second place, they are attracted to the flowers for the nectar which the flowers contain, and visit them in larger numbers than any other class of insects. In the third place, they "use pollen in their business" and are provided with pollen baskets on their legs, so that quantities of fertilizing dust is carried from flower to flower. Every horticulturist should be a beekeeper, not alone for the value of the honey, but for the good which the bees do in the orchard. It has been estimated that if the honey product from the bees of the United States be disregarded entirely, the bees of America would still be a good investment to the country, simply for the good which they do in improving and rendering possible the growth of apples throughout the country.

FERTILIZATION OF THE APPLE ORCHARD.

In orchards where the soil is properly tilled and where cover crops are used, there will be but little need for the employment of fertilizers of any sort. Some varieties, however, do not do well except where a fertilizer is used. This is notably true of the Winesap apple in many parts of southern Indiana. In some sections in the north the Northern Spy must be well fertilized if it is going to produce the most perfect fruit. In general it may be said that the chief value of the fertilizer is simply to increase the thriftiness of a tree. The fruit is but little affected by any fertilizer. In fact the color of the fruit may be seriously injured by the employment of fertilizer, and it is very seldom that we can credit increase in size to the use of any artificial fertilizer. The increase in the size of the fruit can be attributed only to the improved moisture conditions, and improvement in moisture conditions can be produced only by thorough tillage in the summer time. The employment of the dust mulch in an apple orchard will do more to increase the size of the fruit than any possible system of fertilization. In old run-down orchards fertilizer is sometimes of value. This, however, will be discussed in the question of bringing the old orchard into fruitfulness.

USE OF SMUDGE FIRES IN ORCHARDS.

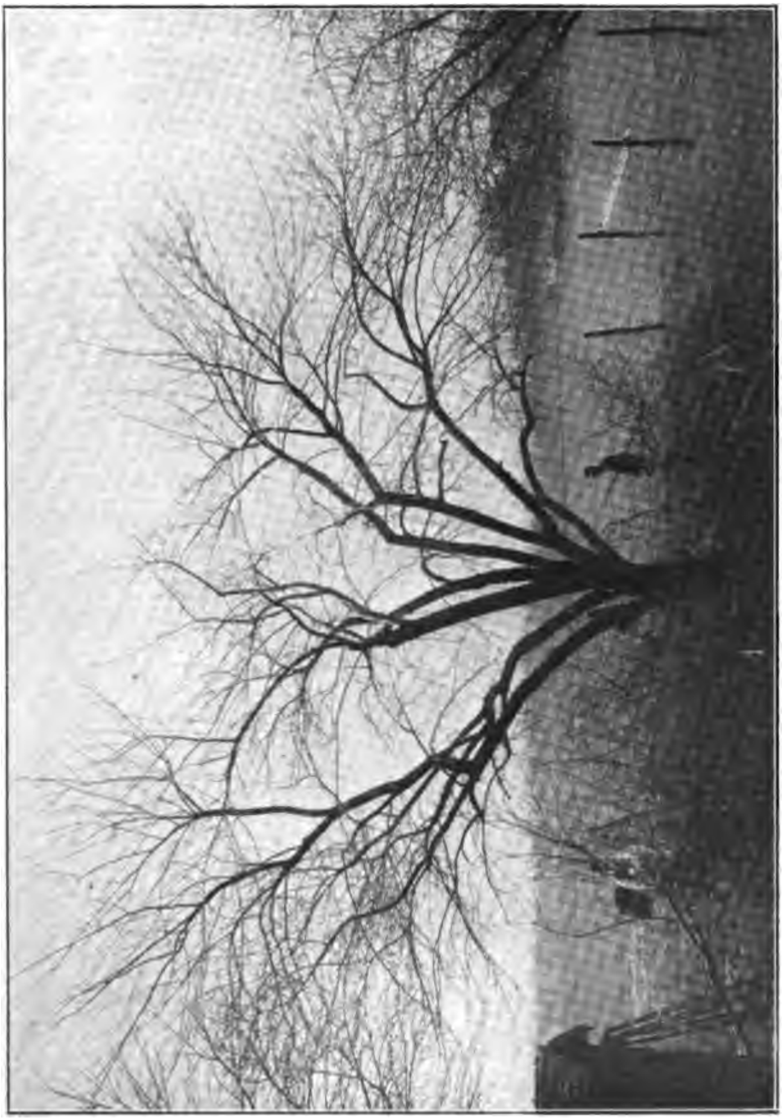
During recent years a good deal of interest has been felt among fruit-growers in the subject of preventing frost injury by the use of smudge fires in the orchard. In this State very little work has been done along this line, though in a few cases experiments have been tried which tend to show that the practice will be of some benefit in Indiana orchards. The annual loss from frost is, of course, very great, not only in this but in all sections, and any system that will tend to reduce this loss will prove of immense economic importance. At the present time experimental work is being carried on with the use of several different styles of smudge pots which are designed for burning crude oil, the idea being to produce a dense smoke that will settle over the orchard and prevent injury from frost. There is still much room for experiment in this field of orchard practice, but it is a line of experiment that I think should be actively carried on by all orchard owners. I believe that much material is wasted in the orchard that could readily be saved and used for smudge fires during the year. I refer particularly to the brush trimmed out of the orchard annually and which is ordinarily carried off to one side and burned. Wherever this trimmed material contains any branches infested with scale insects it is better to burn it at once, but where it consists of clean, superfluous wood, it should all be kept to be used in smudge fires in the spring. While these fires may not be effective every year, there may be seasons when the conditions will be exactly right for their use and when their employment will prove of immense economic importance in the orchards of the State,



A HIGH-HEADED, DENSE-TOPPED TREE IN A NEGLECTED ORCHARD.

BRINGING THE OLD ORCHARD INTO FRUITFULNESS.

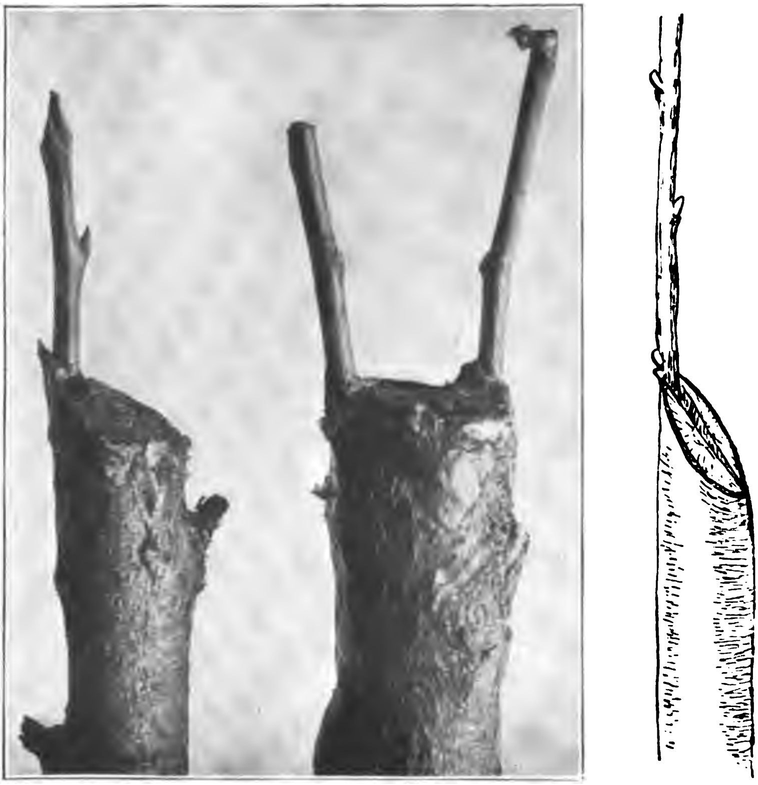
This is a subject that is very difficult to put on paper in such a shape that it will really be of any value to a man who has an old orchard. There are a few points that I believe can be made clear, and by the use of a few photographs I think we can materially assist the owners of old orchards in studying their own conditions and in improving their places. As a general rule we can say that most neglected orchards need, more than anything else, to have the soil stirred. It will certainly not be hurt by a little tillage, and we can adopt the plan that is adopted by some of the Chinese doctors when they are called into a case. Ginseng is such a universal remedy among the Chinese that while the doctor is diagnosing the condition of the patient he usually gives him a piece of ginseng to chew on. Likewise it will be a good plan for us to give the orchard some thorough tillage while we are deciding what else it really needs. In many cases the old orchard will need some vigorous thinning out, due to the fact that the original planter did not realize the size that the apple trees would reach when they were mature, and he was perhaps misled by some enthusiastic nurseryman who desired to sell just as many trees as possible. Wherever thinning is practiced it must be done conservatively, and the trees that are least desirable should be destroyed. The crowded condition of the old orchard usually means that the trees are high-headed and often with many dead branches in the lower portions. This, of course, suggests the necessity for trimming, and very often this is one of the first things that must be done in the orchard. Of course, all dead wood should be thoroughly taken out, and cross branches, which rub one another, should be removed. Branches that are too thick, or that interfere, should not be left on the tree, and the head of the tree should be so opened up that sunlight and air will have access to all the branches and all the fruit. Frequently there may be no immediate results of the pruning of the old orchard. This pruning, however, will get the trees in such shape that they can be handled much better in the matter of spraying and harvesting the fruit. High-headed trees cannot be economically sprayed, nor can the fruit be gathered from them successfully. It will often pay to cut a large tree back a considerable distance in order to produce its fruit at a lower height. This often requires a good



SAME AS PRECEDING, WITH THE TOP CUT OUT.

The head of the tree was lowered ten feet and air and sunlight was admitted to the center.

deal of nerve on the part of the orchard owner, but if the trees are to be made profitable it must be done. In many of the old orchards we find comparatively few varieties that are profitable commercially or desirable for the home orchard. Such trees, if they are thrifty and vigorous, can be top-grafted with good success. However, if the trees are injured, or show any lack of thrift, they should not be allowed to remain in the orchard. It will be cheaper in the long run to remove them bodily and fill their places with young trees of good varieties. In case of top-grafting, the branches to be grafted are cut back and the stubs are cut at an angle shown in the accompanying illustration. The graft is then set at the top of this angle, and the entire union is plastered over with grafting wax. A top graft made in this fashion will usually bear fruit in about two years after the operation. Of course, a commercial quantity of



PROPER METHOD OF MAKING A TOP GRAFT.

(The specimen shown on the left is the better form.)

fruit could not be collected at that time, but a commercial crop from a top-grafted orchard should be harvested in from five to six years.

Often the old orchard will be found greatly in need of a fertilizer. This can be added in any of several different forms. As a general rule, however, I believe that the tillage suggested at the first will take the place of most of the fertilizer needed, although immediate results may be secured by the use of a commercial fertilizer or by barnyard manure. In an orchard that has yielded large crops of fruit there may be the necessity for the application of large amounts of potash. This element is rapidly exhausted from the soil in a heavily cropped orchard. Nitrogen is sometimes deficient, but it may then be supplied by a cover crop of one of the legumes, such as cowpeas or red clover. Sometimes a single old apple tree will begin to show signs of decreptitude after many years of fruitfulness, and may be brought back into fair health by a liberal application of what we call a complete commercial fertilizer containing the necessary elements of potash, nitrogen, phosphorus, etc. This should be applied, not immediately around the trunk, but over the entire surface of the ground, which, for a distance equal to the spread of the branches in all directions from the trunk, should be dug up. The surface is then ready to receive the fertilizer, and this is in a condition where it will reach the roots quickest and do the most good.

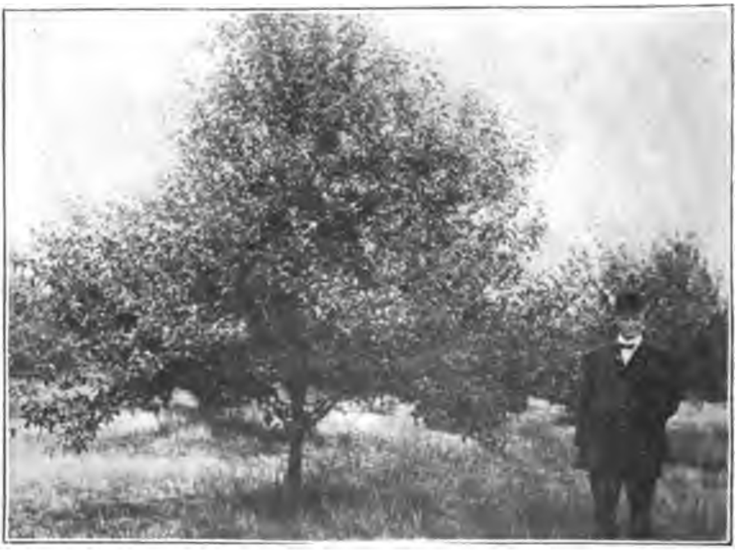
LESSONS FROM SOME INDIANA ORCHARDS.

These notes are taken at random from the notes on orchard inspection made during the last season. It has been the intention to select places where some important point could be illustrated and. of course, only a very small fraction of the places inspected can be written up.

DR. G. C. MASON.

Dr. G. C. Mason owns a splendid young orchard of forty acres just south of Somerville, Ind., in Gibson County. The place has received the best of care, and last summer was in remarkably good condition. I know of few orchards in the State that give better promise for the future than that of Dr. Mason. The oldest trees were planted about nine years ago and are now of nice bearing size. All of the trees have been headed low.

The accompanying photograph is of a Jonathan tree eight years old. It is bearing considerable fruit, and from the behavior of the



AN EIGHT-YEAR-OLD JONATHAN APPLE TREE, PERFECT IN FORM.

This tree is in the orchard of Dr. G. C. Mason.

Jonathan in this section it would seem that this variety would prove a valuable commercial sort.

Dr. Mason is following both the cultural and the mulch systems in taking care of his orchard. He has also used large quantities of manure and wood ashes in forcing the trees to make a strong growth. This vigorous and possibly somewhat tender growth may be responsible for the unusual appearance of blight in this orchard during the present season. A number of the trees have developed the disease on the trunks. Last year there was a little twig blight throughout the entire section in which Dr. Mason's orchard is located.

It was last season that considerable trimming was done in the orchard and many of the lower inner limbs were removed. From these old cuts the disease has made its appearance, usually working down from the stub. In many cases the trees were almost girdled by the disease from the ground to the head of the tree. In some cases a strip of bark as narrow as one inch in width was all that was left to convey moisture to the branches. Trees in this condition were hilled up with soil around the trunk so as to completely cover the affected area. A number of years ago Dr. Mason followed this plan with a tree in his yard at Oakland City and today the tree shows very little result of the injury, the wound having completely healed.

The method of preventing the twig blight by trimming has been discussed fully in another portion of this report and need not be dwelt upon here.

Dr. Mason considers that the following varieties have been tested in his locality to such an extent that they can be recommended:

Jonathan.
Gano.
York.
Banana.
Stayman Winesap.
Fall Pippin.
Wealthy.
Ingram.

In his section it is probable that these recommendations will be a valuable guide by which to go.

He would not plant the Ben Davis owing to its uncertainty in recent years. The Missouri Pippin is short lived. The old Winesap has not done well except when heavily fertilized. The Rome Beauty has not proved to be a hardy sort in this section.

S. W. KELLE.

This orchard probably shows the results of careful attention about as well as any in Indiana. When Mr. Kelle took charge of the place several years ago the trees were already of bearing size and the place was a tangle of briers and had the remains of peach trees planted between the apples. Mr. Kelle took out twelve hundred of these peach trees and grubbed out the blackberries and now has the orchard in the very best of condition. The apple orchard covers some thirty-two acres.

Mr. Kelle prefers the sod system of culture. However he has a drove of hogs in the orchard, and they materially assist in keeping the place clean by eating all the fallen fruit.

Mr. Kelle's experience with the San Jose scale is one which should be a lesson to the fruit-growers of the State. Last year his orchard was so badly infested that practically all of his fruit was disfigured with the insect. He sprayed his place thoroughly last year with the lime and sulphur solution, and it is almost impossible to find any live scales at this time. Mr. Kelle used the lime and sulphur solution after several years' unsatisfactory experience with the miscible oils. Repeated sprayings with commercial miscible oils had barely held the trouble in check and had yielded practically no definite results.

.H. M. WIDNEY.

H. M. Widney has a large orchard in an excellent state of cultivation about three-quarters of a mile northeast of St. Joe.

The orchard has been infested with San Jose scale to a slight extent, and Mr. Widney has been using the home-made lime and sulphur solution. He is of the opinion, however, that the commercial lime and sulphur will be fully equal to the home-made preparation for the control of scale insects.

One of the most interesting things in regard to Mr. Widney's place, and the thing which shows his thoroughness, is the fact that the Purdue Experiment Station desired to use his orchard for experimental work and Mr. Widney would not permit this, owing to the fact that the station desired to leave check trees throughout the orchard. Mr. Widney says that no unsprayed trees are going to remain on his place. This should certainly be a lesson to those who have not started to spray their trees.

STATE ORCHARD.

Several years ago the State of Indiana acquired quite a tract of land at North Madison, Ind., for the site of the Southeastern Hospital for the Insane. On the tract of land there is situated about one hundred acres of orchard of various kinds of fruit. My attention was first called to the place in the fall of 1907, and upon examination I found that the apple orchards were badly infested with the San Jose scale. An attempt was made the following winter and spring to control the pest by the use of commercial lime and sulphur solutions and by the use of miscible oils. At that time the work was conducted mainly with an eye to ascertaining the value of miscible oils for the control of scale insects. Several different preparations were used. The spray-pump which the State owned at North Madison at that time was one of the old type which generated its own power by means of cog wheels attached to the rear wheel of the spray wagon. This type of sprayer is quite effective for small orchards where the conditions are satisfactory in every way. At North Madison we found that the machine worked satisfactorily when the ground was hard and firm, but in wet weather when the ground was soft it was almost impossible to procure enough power to do the spraying thoroughly. This fact, coupled with the fact that we were using miscible oils, made it al-

WINTER SPRAYING AT MADISON, INDIANA.

most impossible to make much headway in the control of the San Jose scale. In the winter of 1908 and 1909 we installed a complete plant for the making of the homemade lime and sulphur solution. The same old spray-wagon was used, however, and in the time available for spraying it was not possible to entirely cover the large orchard; nor was it possible to do thorough work on even a small part of it. As a result the winter of 1909 and 1910 found the orchard still rather badly infested with the San Jose scale.

Russeting caused by Bordeaux.

In the spring of 1910, realizing the condition of affairs, I induced the authorities to purchase a large gasoline power machine. With this apparatus a large part of the orchard was thoroughly sprayed and all of the dead wood was trimmed out. Unfortunately the work was stopped before the west rows of the orchard had been sprayed. On making an examination in the orchard late in the summer of 1910, it was a very easy matter to see just where the spraying stopped. The unsprayed trees are not only in bad condition, with many dead branches and with many branches from which the leaves have fallen, but what fruit there is on these trees is very badly marked and spotted with the scale. On the trees where the spraying was done last winter the fruit is practically free from scale; the branches are clean and the entire trees have a much better, cleaner look. As a matter of fact, some trees that were literally crusted over with the scales are now in a fair state of health. I feel that this orchard should be sprayed again the coming winter with the lime and sulphur solution if the good effects of the past season are to be continued. The fruit in this orchard is not what should be expected, for several reasons. In the first place, the weather conditions at the time the trees were in bloom were such that the fruit was badly fertilized. This always results in imperfect fruit. In the second place, the trees were sprayed with the Bordeaux mixture, in which the lime was evidently of poor quality. Certainly the fruit is very badly injured from the Bordeaux spraying. Then, too, all of the trees are in bad condition owing to the fact that they had long been infested with the San Jose scale, and doubtless the depleted soil in the orchard, which has not been properly cultivated for many years, will all tend to cause the poor fruit which we find on the place at the present time.

ST. MEINRAD'S ABBEY.

FERDINAND, IND.

On July 14th, this year, I visited the orchard at St. Meinrad's Monastery, and was very much pleased to find the orchard in an excellent state of cultivation and well tended.

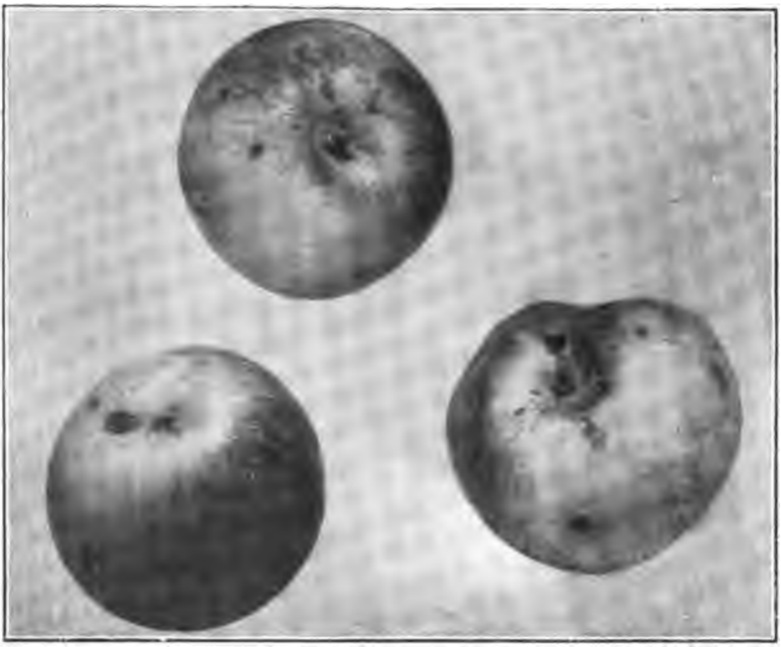
The orchard is under the supervision of Father Celestine, who gives the growing of the fruit his close personal attention. He was anxious for assistance which would aid him in growing more or better fruit. The orchard was not only well cultivated and well pruned, but it had been thoroughly sprayed and the work had been decidedly effective. In one corner of the orchard I found considerable Apple Rust on some of the trees, and learned that the trees had previously been repeatedly defoliated. The Apple Rust is a disease which affects not only the apple, but which causes the characteristic cedar galls on the red cedar. Wherever it is found in an orchard it is always possible to find a red cedar tree (Juniper) some place in the immediate vicinity. In this case I found several large cedar trees just over the fence in one corner of the orchard, adjoining the place where the rust had destroyed the leaves of the apple. This season the trouble had not been so severe, doubtless owing to the fact that the trees had been so thoroughly sprayed with the Bordeaux mixture. As in most orchards where the Bordeaux solution has been used the fruit was decidedly marred with the characteristic Bordeaux injury. This trouble we now believe can be very largely prevented by using the lime and sulphur solution in place of the Bordeaux solution. This, however, will be dealt with later in my report.

The excellent care of the orchard at St. Meinrad's Monastery is proving to be quite an effective object lesson to the farmers throughout the section, and I learned that many spray-pumps had been sold and that the farmers were taking an active interest in the matter of growing better apples. It is a section in which the apple seems to do very well, and there is no reason why large quantities of the fruit should not be raised in that part of the State.

SPRAYING OUTFIT IN NEWHOUSE ORCHARD.

NEWHOUSE ORCHARD.

Early in the spring of 1910 I arranged with a prominent fruit-grower in Indiana to conduct a series of experiments with substitutes for the Bordeaux mixture. During the past two or three seasons some of the progressive experiment stations in other States have been claiming remarkable results for dilute lime and sulphur solution as a summer fungicide. I desired to thoroughly test this matter out in some Indiana orchard, and accordingly planned the experiment mentioned. Unfortunately, owing to an accident, the orchardist who had planned to do the work was unable to complete the experiments as I had outlined them. We were accordingly forced to select some other orchard for the work, and this, of course, necessitated the selection of an orchard close enough to Indianapolis that the work could be supervised and directed from the office.



APPLES FROM CHECK TREE.

For this purpose we selected an orchard owned by W. H. Newhouse, located about two miles west of Lawrence, Indiana, about a mile north of the Indiana Union Traction line. The location of the orchard permitted us to give the place very close attention, and most of the spraying work was under the direct supervision of the head of the department. All of the work was done by the regular field men of the department, who were taken off of the field work for that purpose. In this way the very highest grade of work was done and in the most thorough manner. As stated before, the object of the experimental spraying was to examine the value of different fungicides as compared with Bordeaux mixture. The following solutions were used in making these tests:

Grasselli Brand Bordeaux Mixture.

Orchard Brand Bordeaux Mixture.

Orchard Brand Lime and Sulphur—diluted one part to thirty parts of water.

Orchard Brand Lime and Sulphur—diluted one part to seventy-five parts of water.

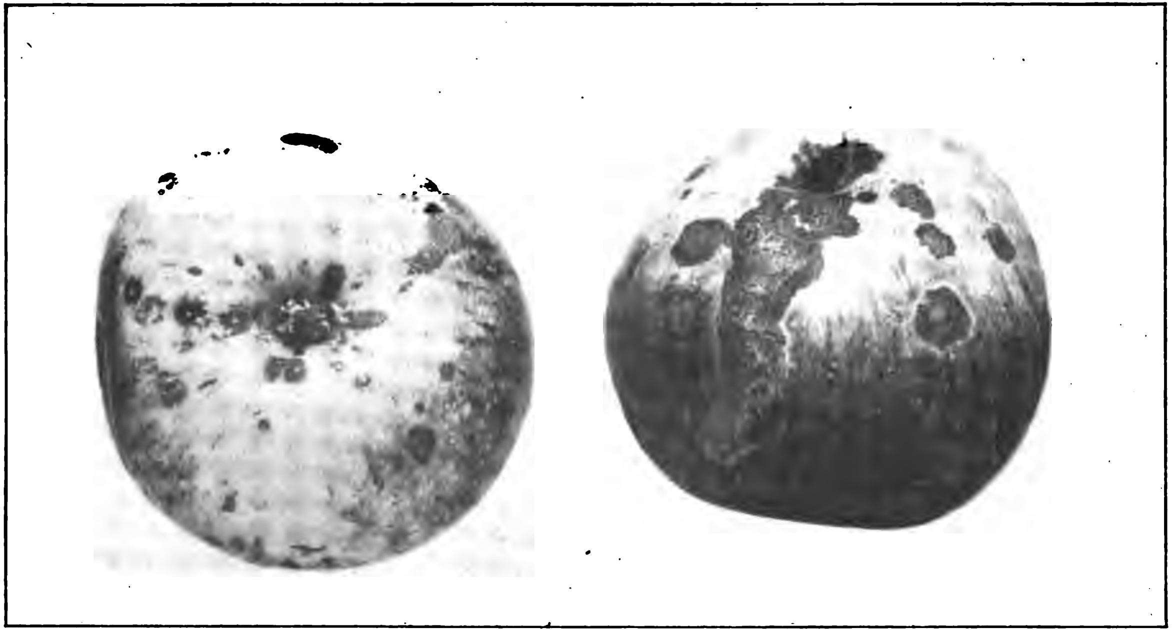
Grasselli Lime and Sulphur—diluted one part to thirty parts of water.

Home-made self-boiled Lime and Sulphur solution, made by the following formula: Fifteen pounds of lime were placed in a large kettle and three gallons of boiling water were added to it. At the same time ten pounds of sulphur and three gallons more of hot water were added. This was allowed to boil by its own heat for about twenty minutes. At the end of this time the solution was of a thick creamy consistency, and enough water was added to fill a fifty gallon barrel.

In addition to these solutions, a fungicide which has recently been put on the market by the B. G. Pratt & Company, of New York, under the name of Sulfocide, was also tested. The first spraying in each case was made just after the petals had fallen and before the lobes of the calyx had had time to close. In no case was any spraying made before the buds opened, although the orchard had been sprayed with the lime and sulphur solution during the winter for the control of the San Jose scale.

The orchard contained probably about seventy-five trees. It had originally contained eighty trees in regular rows, and several of the trees had died out and been removed. Checked trees were left at a number of places to keep tab on the results obtained by the spraying. The orchard contains several different varieties of apples, chief of which are the Ben Davis, Wolf River, Rome Beauty and Jeniton.

A review of the results of one row of trees will serve as a guide to the results throughout the orchard, and for this purpose I will describe the third row of trees from the south side of the orchard.



APPLES FROM UNSPRAYED TREES.

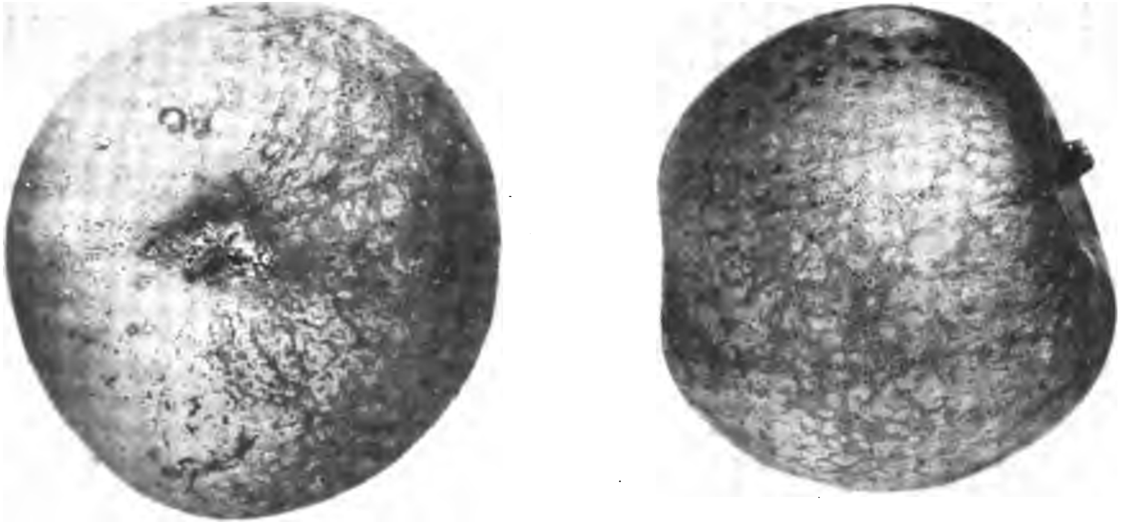
This ruit shows the characteristic effect of the Apple Scab, and both apples are infested with the Codling Moth.

In this row the first tree was sprayed with the self-boiled lime and sulphur solution. An examination made late in the summer showed that the fruit on this tree was practically perfect, although a check tree joined it on the south. The fruit is smooth, exceedingly free from Apple Scab, and of course, free from insects, as a sufficient quantity of arsenate of lead was added to all fungicide solutions to control any insects that might be present. It was desired to eliminate as far as possible the insecticidal end of the experiment. No other attention was paid to the matter of insect control at all. The experiment was intended to bring out the value of the different fungicides. For this reason no special mention is made of the value of the experiment from an insecticidal standpoint.

I think that probably the first tree, which was sprayed with the self-boiled lime and sulphur solution, is in as near an ideal condition as any tree in the entire orchard. The tree adjoining it on the east (the next tree in the row) was sprayed with the Orchard Brand Lime and Sulphur solution in the proportion of one part of the solution to thirty parts of water. This tree, which was examined at the same time as the preceding, shows very nearly the same results obtained from the home-made solution. I believe, however, that the Self-Boiled Lime and Sulphur solution showed some points of advantage over the commercial preparation at one to thirty. I believe, too, that the strength of one to thirty is, perhaps, stronger than is necessary for the control of the Apple Scab.

The third tree in the row was a check tree and was not sprayed. This tree was in not only a bad condition, but it was almost impossible to find an apple on it that was not marked either with some insect injury or with the Apple Scab. The Apple Scab is by far the worst apple disease in the section where this orchard is located. It was noticeable, too, that the apples on the tree next the sprayed trees were more nearly free from Apple Scab than were those on the main body of the tree. This, of course, was due to the fact that some of the spray solution from the sprayed trees was unavoidably thrown on the check trees. The reverse condition is also true in that we find where the check trees are left standing next to a sprayed tree there is liable to be some Apple Scab on the sprayed tree in spite of the fungicide applied to it. The check trees will always cause this slight difference in results.

The fourth tree in this row was sprayed with the Graselli lime and sulphur in the proportion of one to thirty. There was prac-



TWO APPLES FROM TREES SPRAYED WITH BORDEAUX MIXTURE.

Showing the characteristic russeting of the fruit.

tically no difference in the results obtained with this solution and with the Orchard Brand lime and sulphur.

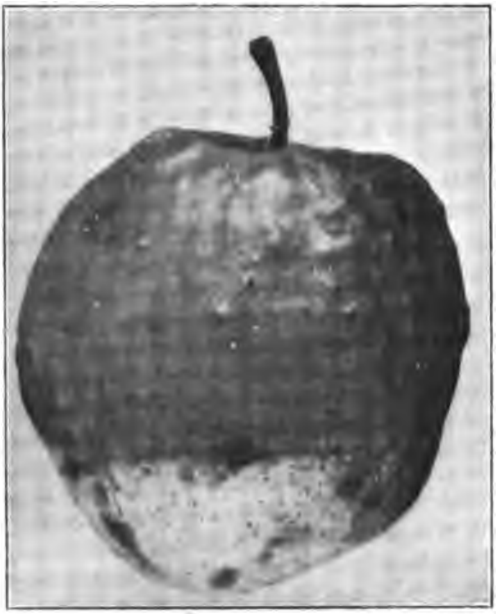
The fifth tree in the row was sprayed with Pratt's Sulfocide, and with doubtful results. The solution as it came to us was intended to be used in the proportion of one part of the solution to one hundred and fifty parts of water. It was used at this strength and damaged the foliage to a marked extent. The damage on the Ben Davis trees was not nearly so marked as on other varieties. The foliage of the Rome Beauty was badly burned, while one York Imperial tree was almost defoliated by the preparation. It has undoubted value, however, for the control of the Apple Scab, for trees on which Sulfocide was applied show practically no markings from this disease. I believe, however, that if the Sulfocide is used

SPRAYED WITH LIME AND SULPHUR.

at a greater dilution than is recommended by the manufacturers it will prove to be a valuable substitute for the Bordeaux mixture. I can see no reason, however, for using it in place of the home-made lime and sulphur solution, which is not only cheaper but very easily prepared and undoubtedly effective.

Tree number 6 in this row was sprayed with Grasselli Bordeaux Paste solution, and while the Apple Scab is controlled to a very marked extent, practically all of the fruit shows the characteristic Bordeaux markings, or roughenings, which are present on nearly all trees where this solution is used. The Bordeaux solution has been objectionable for many years on account of this habit of marking fruit in this way.

Tree number seven was sprayed with the Orchard Brand Bordeaux and is in practically the same condition as is the tree sprayed with the Grasselli Brand of Bordeaux. The tree joining it on the east is a check tree, and that fact may account for apparently poorer results with the Orchard Brand solution than with the Grasselli solution. There are some apples on the east side of tree number seven that show some Apple Scab. This doubtless comes from infection received from the check tree mentioned. On the other hand, the check tree, which is the end tree in the row on the east side of the orchard, shows some almost perfect fruit on the side next to the tree sprayed with the Orchard Brand Bordeaux. All the trees in this row were Ben Davis trees, so that the results are comparative for this particular variety. The results, however, hold good on practically all varieties tested, the only exception being that some varieties were found



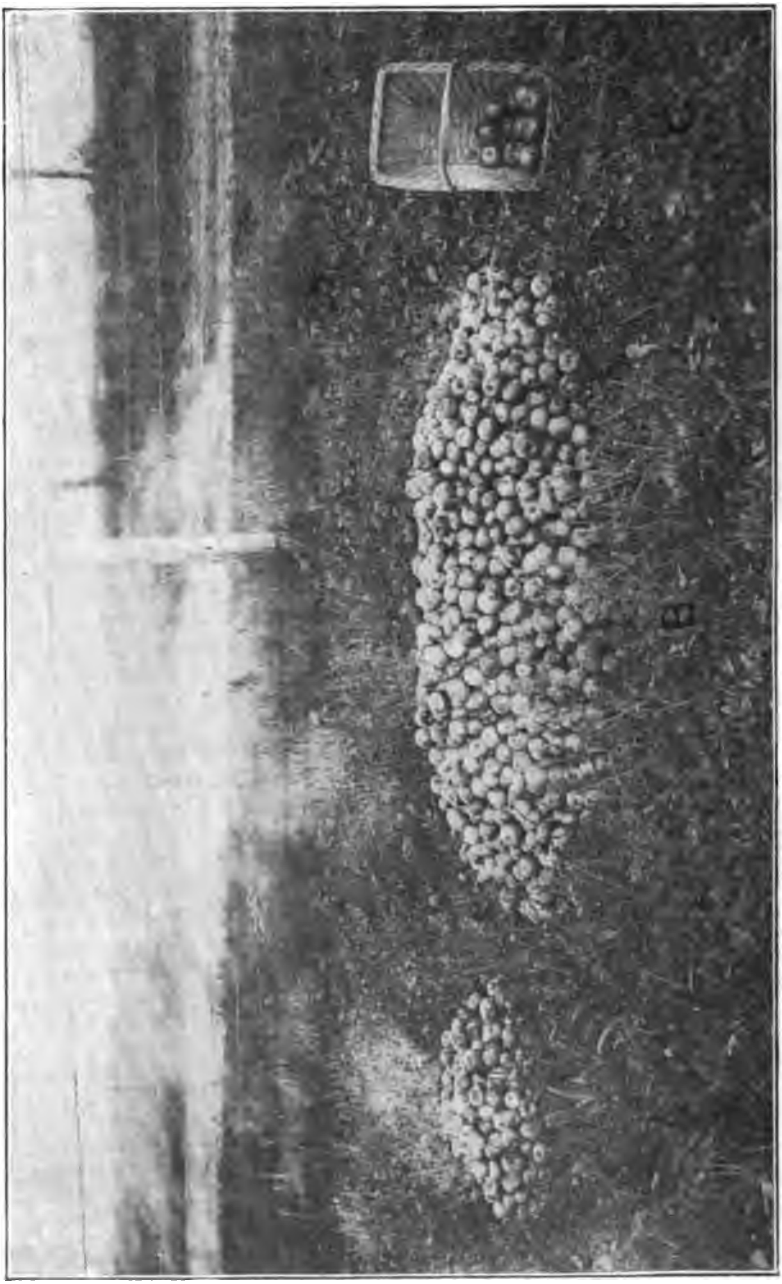
Russeting of apple caused by frost. An injury similar to, but distinct from the Bordeaux injury.

A ROW OF FRUITING TREES IN THE NEWHOUSE ORCHARD.

to be more susceptible to leaf injury than were others. This seems to be noticeably true of the York Imperial and the Rome Beauty. Both varieties suffered more or less from leaf burning from all of the solutions excepting the Bordeaux solution and the lime and sulphur one to seventy-five solution. I think that the one to seventy-five will not be an effective fungicide, though I believe it can be used one to forty and still give practically the same results. It is probable that a solution of one to forty will give all the results which we obtained with the one to thirty solution, and at the same time cause practically no injury to the foliage.

Unfortunately the self-boiled solution was used only on the McAfee and the Ben Davis varieties. The one to seventy-five lime and sulphur was used on the Jeniton and on the Rome Beauty. On the Rome Beauty quite a marked result was obtained, but on the Jeniton but very little difference was noticed between the sprayed tree and the check tree joining it. Three Rambo trees in the northeast corner of the orchard serve as a remarkable illustration of the possibility of controlling the Apple Scab. The tree in the north corner of the orchard was left as a check tree, and on it practically no perfect fruit could be found.

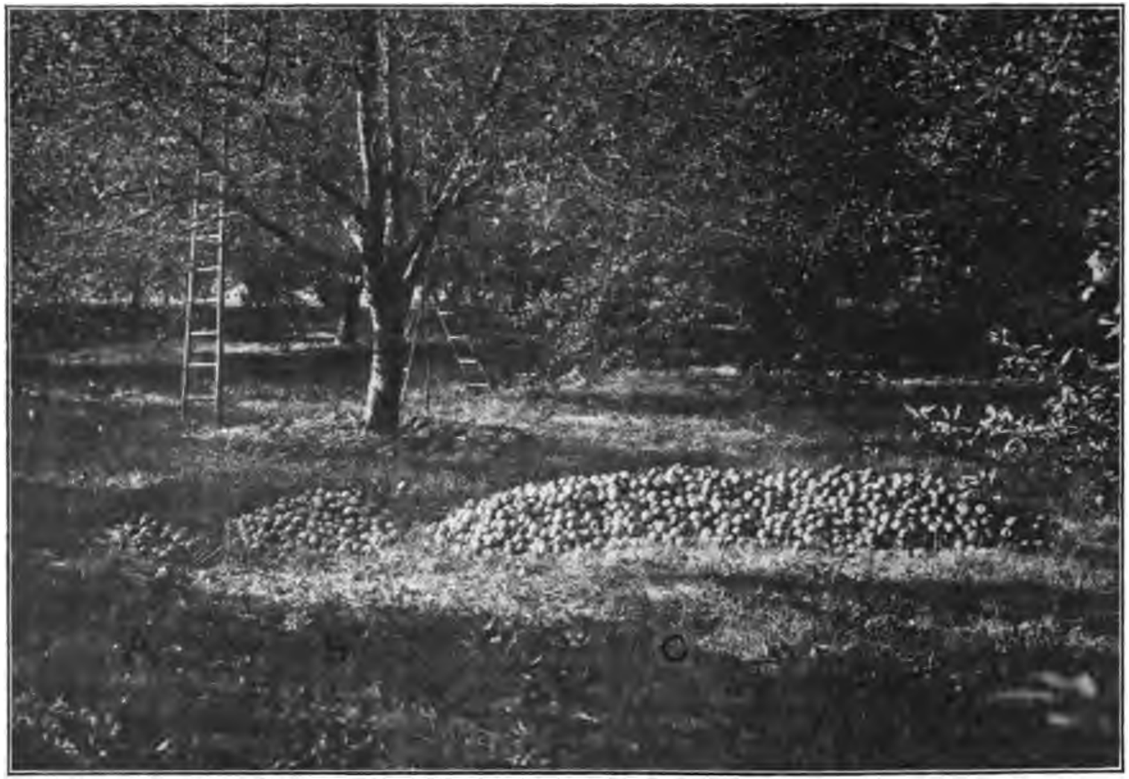
Every apple was either damaged by the Apple Scab, by plum cr apple curculio, or by the Codling Moth. The tree joining it was sprayed with the Orchard Brand Bordeaux, and almost the reverse conditions were true. Practically all of the fruit was perfect save for a few apples on the east side of the tree, joining the check tree, where some scab was present. This condition, by the way, was true throughout the orchard and the trees joining the check trees showed some infection. The next tree was sprayed with Grasselli lime and sulphur, one to thirty, and it was in very much better condition than the trees sprayed with the Orchard Brand Bordeaux solution. This does not necessarily indicate that the solution is a better fungicide than the Bordeaux, but we must take into consideration the proximity of the check tree, which, of course, affected the results in this particular case. The objectionable Bordeaux damage was, however, present on the fruit on this particular tree, while the fruit on the tree sprayed with the lime and sulphur was not only free from Scab but was also free from all injury which might be attributed to the spray solution. The entire orchard has undoubtedly been a valuable object lesson for not only this locality, but for the entire State, and I consider that the value of the lime and sulphur solution as a fungicide has been demon-



BEN DAVIS CHECK TREE.

A. Windfalls. B. Imperfect fruit. C. Perfect fruit.

This tree yielded nine bushels of imperfect fruit, one and a half bushels of windfalls, and twelve perfect apples.



APPLE TREE SPRAYED WITH SULFOCIDE.
A. Windfalls. B. Imperfect fruit. C. Perfect fruit.

The tree yielded one-half bushel of windfalls, two bushels of imperfect fruit, eighteen and one-half bushels of perfect fruit. This tree is practically the same size as the check tree shown.

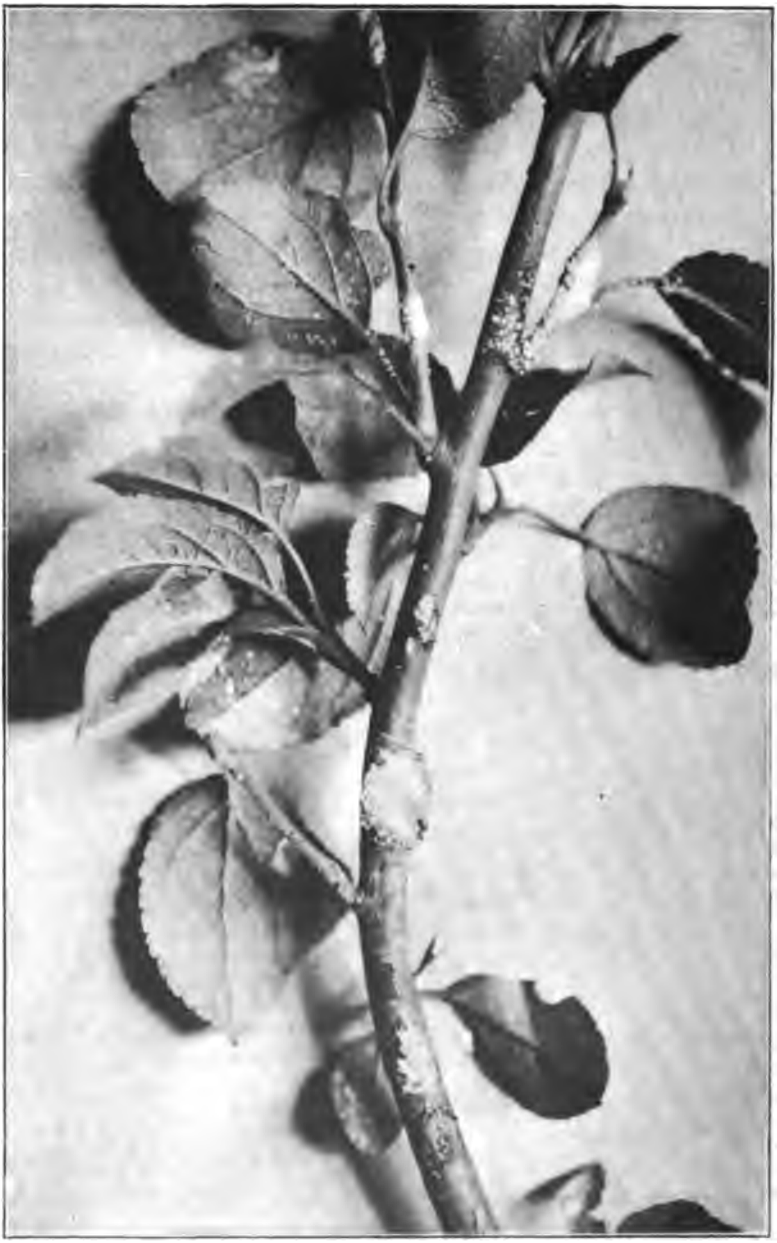
strated for our locality beyond any question. There is, of course, more work to be done to determine the strength which will prove to do the most effective work, and it is my intention to use this same orchard, if possible, another season. At this time, however, the owner states that he will not allow any more unsprayed trees to remain on his place. For the sake of science, however, it is possible that we can change his view of the matter, and he may possibly allow us the very generous use of his place for another season.

INSECTS AFFECTING THE APPLE.

In the following list I will consider the principal insect enemies of the apple and will divide the pests in several classes according to the portion of the tree upon which they commonly feed. I think that such a division will render it a little easier for the orchard owner to locate the particular pests which may be causing trouble.

INSECTS INJURING THE ROOT.

Woolly Aphis (Schizoneura lanigera). This is the chief insect attacking the roots of the apple tree. It is of very common occurrence throughout the State and is distributed practically over the entire State occurring on orchard trees and nursery stock in almost all localities. This is one of the insects that is usually planted with the tree, the insect being on the roots of the tree when it arrives from the nursery. The insect is a small, reddish colored louse which secretes a cottony substance over the body and where masses of them occur on the roots they look like small wads of cotton. When this cotton is scraped away the reddish bodies of the insects can readily be seen. Ordinarily the aphids feed on the roots, causing small galls. These insects on the roots may so sap the vitality of the trees as to cause the death of them. This may occur any time in from one to ten years after they are planted. In the spring of the year a form of the insect appears on the trunk and branches of the apple tree and clusters in large numbers on any rough or wounded places on the trunk. This form of the insect is winged and may fly from tree to tree. It is in this manner that the pest is spread through the nursery or throughout an orchard. The trees should be watched in the early summer and wherever this form occurs the trees should be sprayed with a strong contact insecticide. The best control of the insect, of course, is to see that the trees are perfectly clean when they are planted. This merely means a little care on the part of the planter in examining the trees which he gets from the nurseryman. No tree showing any evidence of the presence of the root louse should ever be planted but should be destroyed immediately.



WOOLLY APHIS ON BRANCH OF APPLE TREE

White Grubs (Lachnosterna sp.) The White Grubs are the larvæ of various beetles, principally of the genus Lachnosterna As a rule they are injurious to apple trees only in the nurseries where they eat the roots of the young trees. They are frequently injurious to young trees planted in grass lands. The beetles of this genus commonly infest such land. The best preventative is fall plowing, which will bring many of the beetles to the surface, where they will be destroyed with the winter freezes. It is a good idea to turn hogs into a piece of grass land before the trees are planted. Hogs are of the greatest benefit in ridding a piece of ground of these particular beetles.

INSECTS AFFECTING THE TRUNK AND BRANCHES.

Round Headed Borer (Saperda candida). This is one of the commonest insect enemies of the apple and may be found in nearly all neglected apple orchards. The adult beetle is about three-fourths of an inch long, of a light brown color, and with two creamy white stripes extending from the head to the tip of the abdomen. The eggs are laid on the trunk of the tree, near the ground, in June or July. The life of this insect, as given by Dr. Phelps of the University of New York, follows:

"The young borer, on the approach of winter, descends as near the ground as the burrow will allow and remains inactive until the following spring, when it begins operation anew. On the approach of the second winter it is about half grown and still living in the sap wood. It is at this period that the most damage is done, for when four or five occur in a single tree they almost girdle it. The next summer, when it has become three-fourths grown, it cuts a cylindrical passage upward into the solid wood and, having finished its larval growth continues this passage to the bark, sometimes cutting entirely through a tree to the opposite side and sometimes turning back at a different angle. Several borers in one tree will fairly riddle its base. The upper end of the passage is stuffed with fine borings and the forepart with long wood fibres. After this the larva remains unchanged through the winter, transforming to a pupa the following spring, and the beetle appears some time during the summer, leaving through a circular exit hole."

It will thus be seen that the beetle requires nearly three years to complete its development. Working as it does through the interior of the tree, it is an exceedingly hard pest to combat. Wherever its presence is suspected the borers should be dug out and destroyed. If this operation is carried on carefully it will result in less injury to the tree than if the beetles were left unmolested. It is an excellent plan to coat the trees with some repellent, such as whale oil soap, in the season of the year when the insects are laying their eggs. This should be applied to the trunk of the tree from the ground up to the first branches. Whitewashing the trees may also be of some effect, particularly if the whitewash is poisoned with a sufficient quantity of arsenate of lead. In this way the young borers, when they hatch from the eggs, will be poisoned before they gain entrance to the sap wood.

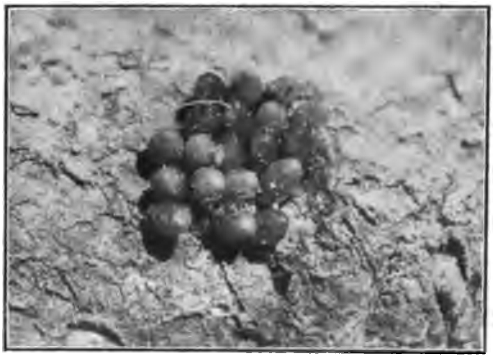
Flat-Headed Apple Borer (Chrysobothris femorata). This is one of the most injurious boring insects, and attacks, not only the apple, but other species of fruit trees. Unless the tree is completely girdled it may live for a long time with these borers present. The eggs are laid by the adult beetles under scales of bark some time in June or July. The young larva, as soon as it hatches, enters the wood and begins feeding. When it has about reached its full growth it leaves the sapwood and enters the harder wood of the tree, where it eventually changes to an adult and crawls to the open air. But one year is required for the life cycle of the insect. Like all boring insects this is an exceedingly difficult form to control, owing to the fact that no poisonous application can be made which will reach the feeders. What has been said in regard to the control of the Round-Headed Borer applies to this insect.

Fruit Tree Bark Beetle (Scolytus rugulosus). This is a small, black beetle that injures the apple and many other varieties of fruit trees by boring between the wood and the bark. As a general rule the insect attacks only trees that have been injured from some other cause and it frequently follows the work of the San Jose scale and completes the damage started by that insect. There are several broods of the beetle each season and they may be found in all stages of development throughout the summer. Infested trees cannot be saved after this beetle once gets a start and all trees found to be infested should be cut down at once and burned, in order to destroy the beetles which they contain. Sometimes only one or two branches on an otherwise healthy tree will be attacked by this insect. In that case only the affected portions need to be cut out and burned. The best control of the insect is to keep the orchard in a good state of cultivation, so that the trees are not weakened to the point where they will become attractive to this particular beetle. It is not a form that the good orchardist need fear in any way.

Curculio Twig Girdler (Ithycerus noveboracensis). On May 28, 1909, I visited the orchard of Mr. M. A. Woollen in Brown County and collected a number of large curculio beetles that were girdling the twigs of the peach and apple trees. I found a number of the beetles at work, so that there could be no doubt of the guilt of this particular form. They seemed to work at the base of the young twigs, gnawing the wood to such an extent that the twigs would break off. It was reported that this insect had been injurious in this locality for the last two years. The insects were controlled by going over the orchard carefully and gathering the beetles by hand and destroying them. This was possible owing to the fact that the trees were small and every portion of the tree could readily be seen by a man walking over the orchard. In the case of large trees, spraying with any arsenical preparation would have been recommended. This season this beetle appeared again in injurious numbers and was combated in the same manner suggested above. There is no reason to believe that the insect will become a seriously injurious form.

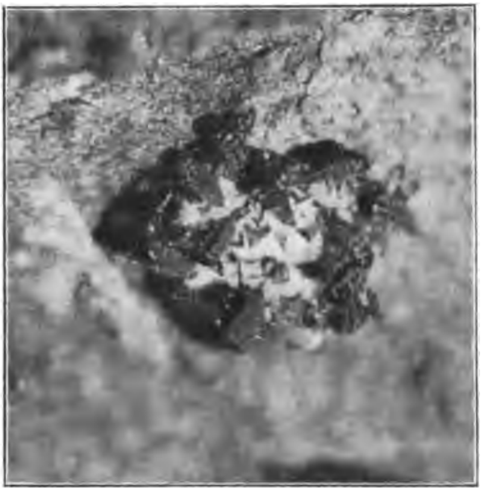
San Jose Scale (Aspidiotus perniciosus). This insect should be familiar to all fruit growers of the State, as it is distributed over the entire area of Indiana. For the benefit of those who are not familiar with the insect, the following life history is reprinted from my first annual report:

The San Jose scale begins life as a minute, orange-yellow insect. crawling freely about over the trunks and limbs of the tree whereupon its parent is attached. It is in this stage that the pest is most generally distributed by birds. It will crawl on the feet and legs of the birds and will often be carried great distances before it crawls off onto another tree.



Egg cluster of the Twice Stabbed Lady Bug magnified about ten diameters.

Picture shows the form and grouping of the eggs very well. They are of a deep orange-yellow color.



A colony of recently hatched larvae of the Twice Stabbed Lady Bug.

This period of activity continues, at the most, for a day or two, when the young scale settles down and begins to secrete the plate or scale proper, which cements it firmly to the bark. It grows during the summer, feeding on the plant juices, which it draws through the bark with its proboscis, and in the early fall the eggs are fertilized in the body of the females by the winged male.

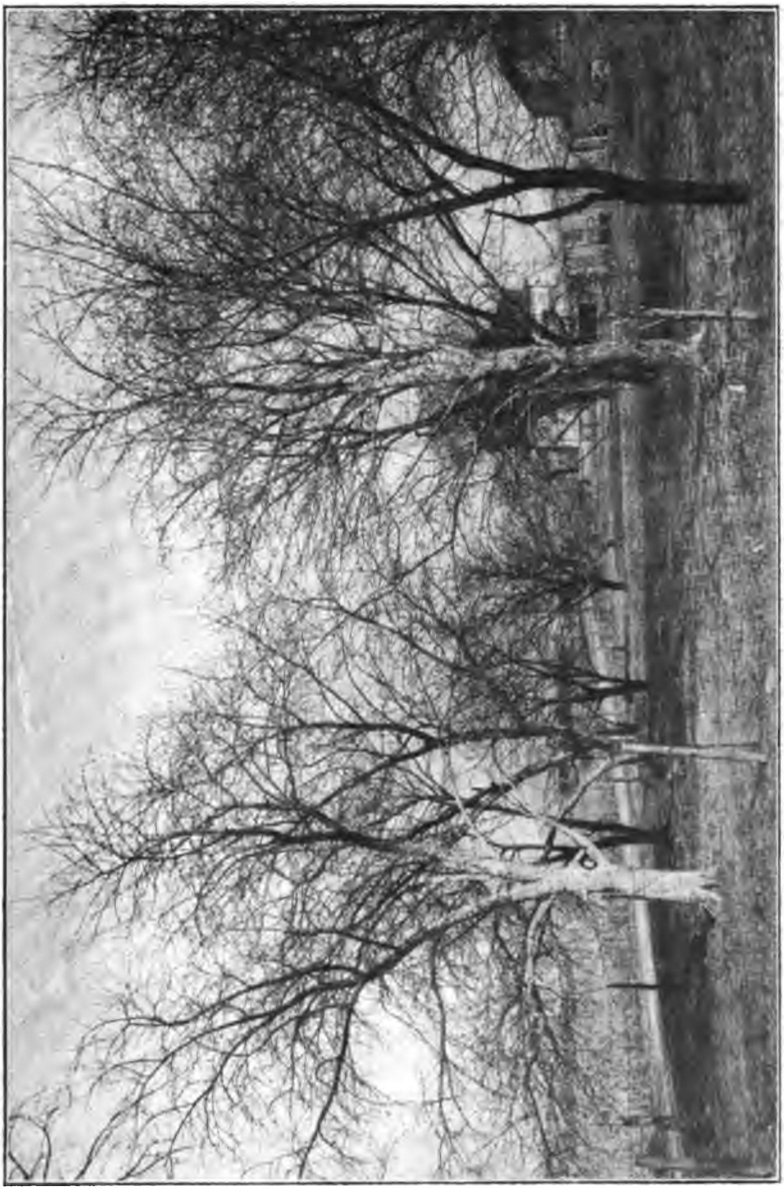
At the approach of winter the insect, still containing the half-grown young, ceases feeding and becomes dormant, to resume feeding at the first approach of warm weather. Early in the spring the young emerge from the body of the parent, thus completing the life cycle.

In Indiana the San Jose scale produces several broods each season, and we can find the active yellow larva at almost any time during the summer. As winter approaches many of the scales are killed by the cold and only the well-established individuals live until spring.

The male scales never live through the winter in the latitude of Indianapolis.

Adult Scale. The adult scale appears as a small rounded plate, grey in color, the center darker and elevated, the whole insect not more than one-sixteenth of an inch in diameter. On a badly infested tree the scales will be close together and completely hide the bark, giving the branch an unhealthy, scurfy look.

It should be noticed that the form of the male and female scale plates is very different, that of the male being elongated to accommodate the wings. The San Jose scale is the most difficult of all scales to control, for two reasons. In the first place, it multiplies very rapidly and is relatively free from parasitic enemies. In the northern part of Indiana a large percentage of the scales are killed by freezing. In the southern part of the State only the males are



A BAD EXAMPLE OF SPRAYING FOR SAN JOSE SCALE.

Notice that only the trunks are coated.

winter-killed, and in some seasons even they may withstand the effects of the cold. This fact renders the scale conditions in the south worse than in the north—though they are bad enough everywhere.

At the present time the control of the San Jose scale is a comparatively simple matter for any orchardist who desires to take the trouble to spray his trees with the lime-sulphur solution. The lime-sulphur solution will kill any scale insect with which it comes in contact, and its use will be otherwise beneficial in any apple orchard. The trees must be sprayed in the dormant season, either in the fall of the year or before the buds open in the spring. Spraying, of course, should not be done in freezing weather in any case.

APPLE ORCHARD AT MADISON, IND.

Trees completely coated with lime and sulphur.

The lime-sulphur solution is the only solution that we recommend for the control of scale insects and is the only solution of which I know that can be seriously considered as a scale destroyer. I have thoroughly tried the miscible oils which are now on the market and I do not feel that I can conscientiously recommend any of them for the control of the San Jose scale. As mild contact insecticides, they have their place, but for the serious control of insects like the San Jose scale, I do not feel that they can be recommended. The simplicity of the lime-sulphur solution has been one of the things that has held it back from prominence. The average farmer does not see how so simple a thing as a solution of lime and sulphur can successfully eradicate an insect like the San Jose scale, for which so many different things have been advised. Several times recently men have come into the office and told us that they had sprayed their trees with the lime and sulphur solution, to which they had added a quantity of carbolic acid, to increase the effectiveness of the treatment. When this statement was first made in the office I did not really know what effect the carbolic acid would have on the lime-sulphur solution, so we tried it—with the result that the sulphur was immediately precipitated from the solution and, of course, the insecticidal value of the solution was ruined. It is not necessary to add anything to the home-made lime and sulphur solution to cause it to do effective work in killing the scale. There are several brands of commercial lime and sulphur on the market, most of which are of excellent quality, and I believe they will do the work fully as well as the home-made solution. In no case, however, should these commercial lime and sulphur solutions be diluted more than one to ten. Any lime and sulphur solution which is sold to be diluted much more than this is probably a fraudulent preparation. The formula for making the home-made lime and sulphur solution is to be found elsewhere in this report.

Scurfy Scale (Chionaspis furfura). This is the commonest of all apple scales and may be found in practically every apple orchard in the State. It does not ordinarily occur in sufficient numbers to be a serious economic factor, though some seasons and in some localities it becomes a rather difficult thing to control. Last season was notably a bad year for this scale, and many much exaggerated specimens were sent into the office. The scale is whitish in color, and male and female are of different shapes, as indicated by the accompanying cut. The scales winter in the egg state, the eggs being deposited under the scale of the old female. This makes them rather difficult to control, for the eggs are not only somewhat resistent themselves, but are protected by the old scale of the mother. Most cases, however, will yield to treatment with the lime and sulphur solution, which should be applied in the dormant season of the year, either in the fall or in the spring before the buds open.

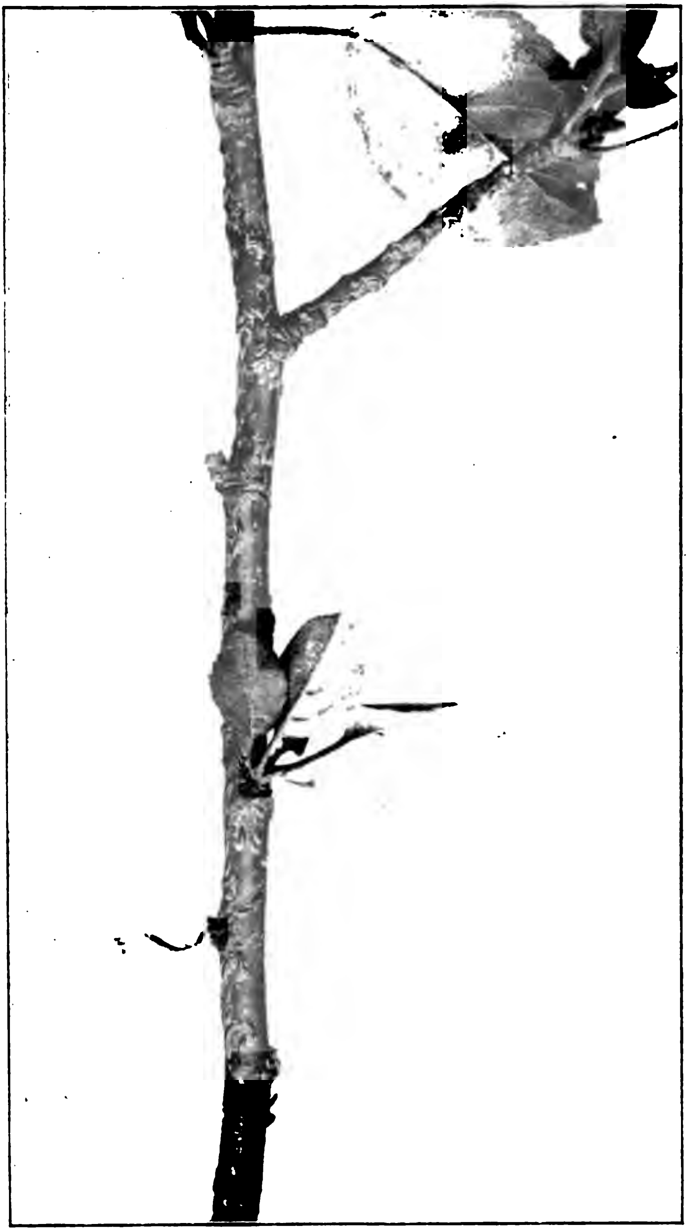
Oyster Shell Scale (Lepidosaphes ulmi). This scale, like the Scurfy, winters in the egg state and is very difficult to reach in the winter season, as the shell of the female scale is much thicker and more resistent than the shell of the Scurfy scale.

I have reports of good success in the control of this scale by the use of the lime-sulphur solution, but this sometimes fails. When it does fail the grower must watch the insect closely and determine just when the young scales hatch out. There is only one brood of the insect during the year, and when the young scales emerge they can be readily destroyed by a mild contact insecticide, such as miscible oils or coal oil emulsion. The young scales usually appear as soon as the warm weather is thoroughly established in the spring, but this seems to vary some from year to year and must be watched for in each particular case.

The Snowy Tree Cricket (Oecanthus niveus). This beautiful little cricket does damage to the apple by laying its eggs on the young twigs and by eating the fruit. The eggs are laid in rows on the smaller twigs, and they pass the winter in this situation. The adults do considerable damage in some localities by eating into the fruit of the apple.

This is one of the injurious insects that at least in part pays for the damage which it does by acting as a parasite on other insects. When the young hatch in the spring they are predaceous on many species of plant lice and doubtless destroy considerable numbers of them. However, the form is to be considered more as an injurious insect than as a ben-

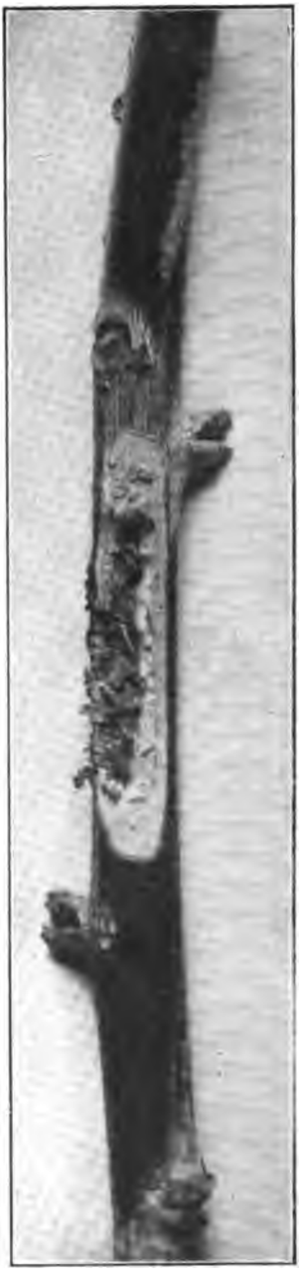
Scurfy Scale—Male and female.



OYSTER SHELL SCALE—NATURAL SIZE.

eficial one. It is controlled in part by our insectivorous summer birds eating the adults, and by the Downy Woodpecker, which destroys many of the eggs in the winter time. I have often watched this small black and white woodpecker industriously at work ripping open twigs that were infested with the Snowy Cricket eggs, and a subsequent examination of the work showed that it had been very thorough.

The Adult of the Snowy Tree Cricket.

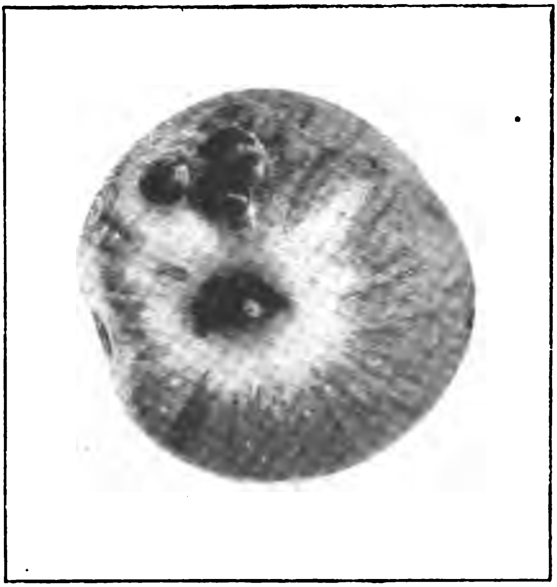

Egg Punctures of the Snowy Tree Cricket.

Buffalo Tree Hopper (Cerasa bubalus). This sucking insect, belonging to the true bugs, lives on succulent plants until late in the summer. In the autumn it stays in the orchard to lay its eggs on the young twigs. These eggs pass the winter and hatch out the following spring, leaving small scars on the twigs of the tree. The direct injury to the tree is of course quite small, but it is of great secondary importance, as these small scars are excellent entrance points for various sorts of fungi. Damage from the insect is to be avoided as much as possible for this reason. As the insect lives for the greater part of the summer on the succulent plants, such as growing weeds, it is obvious that clean culture of the orchard in early summer will do a great deal to prevent the injury from the insect. Thus we have another very excellent argument in favor of thorough orchard cultivation.

INSECTS INJURING THE LEAVES.

The Canker Worm (Spring—Paleacrita vernata. Fall—Anisopteryx pometaria). There are two forms of the Canker Worm known as the Spring Canker Worm and the Fall Canker Worm.

The larvæ of the Canker Worms are commonly known as Measuring Worms or Loopers, because of their peculiar mode of locomotion. They are too well known to require any special description in this place. This particular caterpillar is often overlooked when it occurs in small numbers on the trees, because of its curious habit of becoming rigid when disturbed. In the rigid condition the small caterpillars appear as stiff twigs on the surface on which they are feeding, and have but little resemblance to a crawling creature. The females of all the canker worms are wingless and must crawl up the tree in order to deposit their eggs. In the fall form the adults appear in the fall of the year and lay their eggs on the twigs and these eggs carry the insects over until the next year, hatching in the spring. The spring form winters as a pupa in the ground. Both of the caterpillars appear at practically the same time. They are among the most injurious orchard pests that we have and in some sections and at some times become exceedingly injurious. They have been called Fire Worms, from the fact that the trees on which they have been feeding appear as though scorched by fire. They can be controlled by any arsenical spray, but the fact that the female is wingless gives us

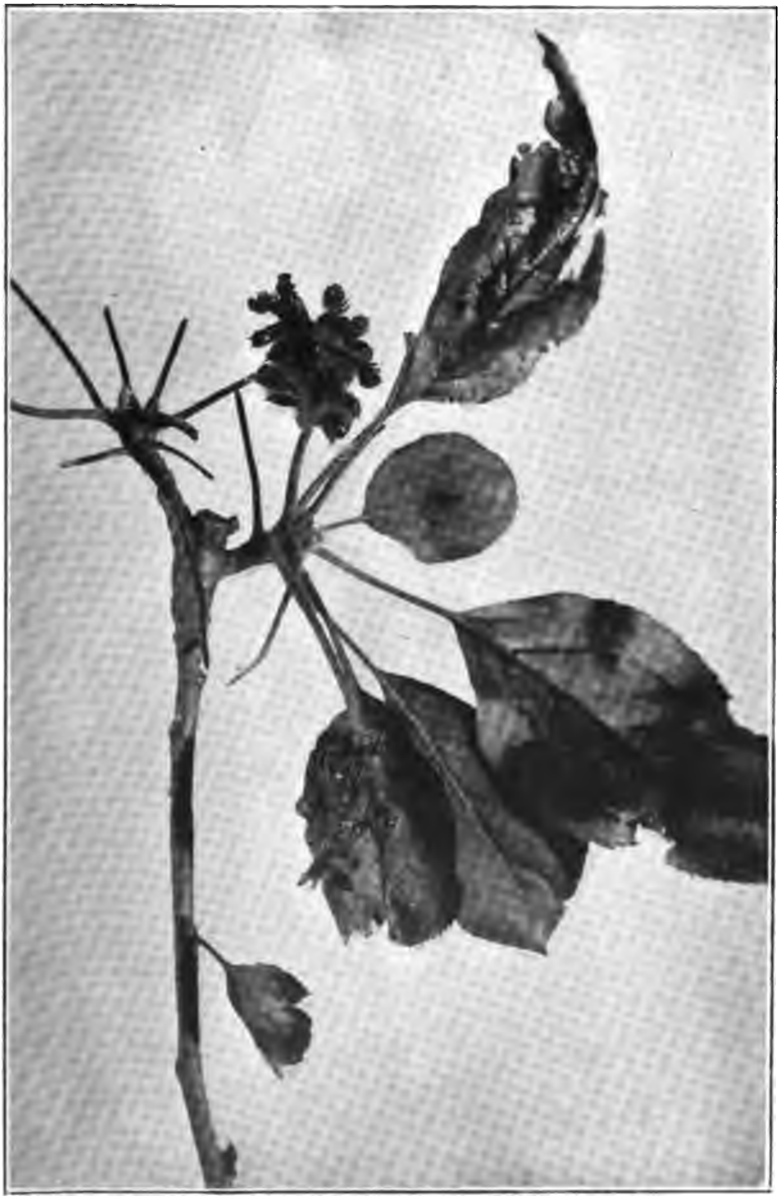


Holes Eaten by Snowy Tree Cricket.

A CLUSTER OF CATERPILLARS OF THE WALNUT WORM.

a clew to a method of control which is often practiced. This is simply banding the trees with some sticky material that will prevent the female moths from crawling up into the body of the tree. Considerable care must be exercised in this work. No banding

CLUSTER OF YELLOW-NECKED CATERPILLARS.

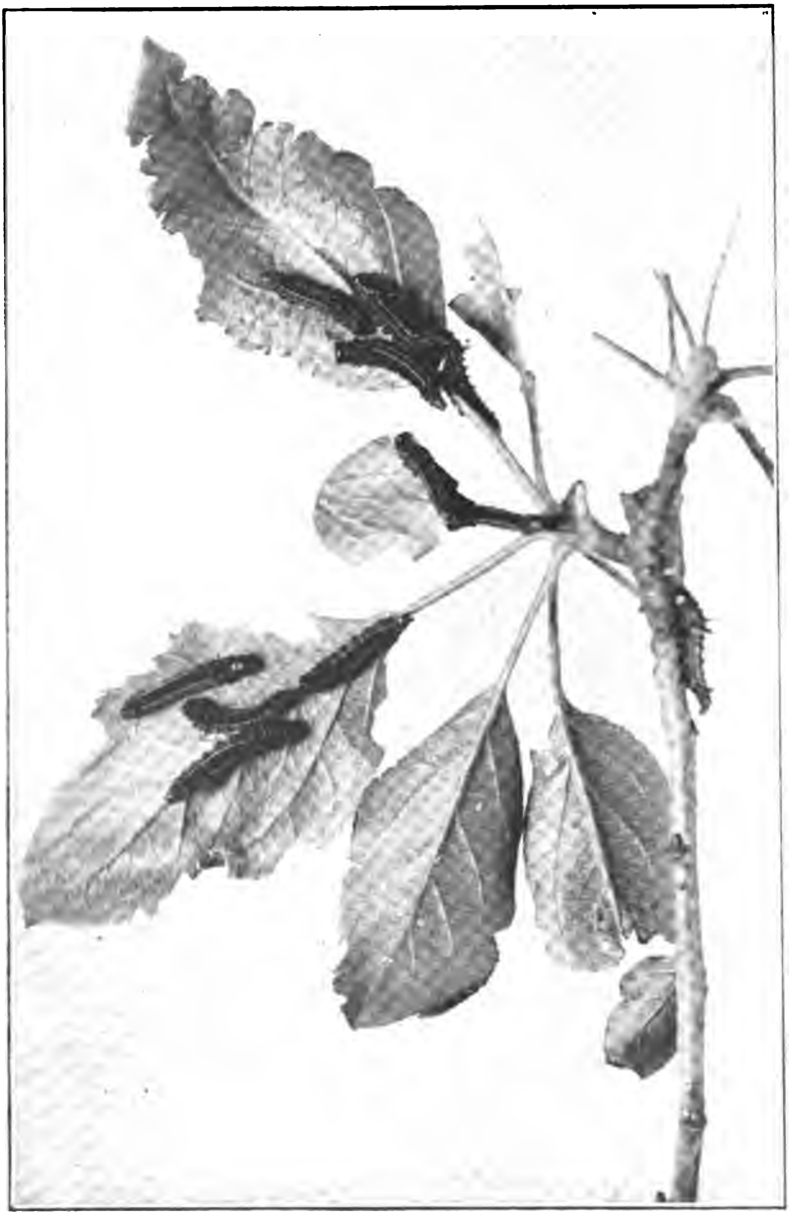


YELLOW-NECKED CATERPILLAR.

material which contains tar or any mineral oil should ever be used, as it is almost certain to result in injury to the tree. Sticky fly paper has been used with good success, but in large orchards it becomes expensive.

Yellow-Necked Apple Worm (Datana ministra). The larvæ of this interesting apple worm is gregarious in its habits and frequently does considerable injury to apple orchards. The caterpillar has a dull orange spot just back of the head and may readily be recognized by this character. While they feed in groups, they do not live in the web, but work in considerable colonies. When disturbed the larvæ have the habit of jerking their heads from side to side vigorously, and it is thought that this habit has been acquired in an effort to scare away the adults of several species of parasitic flies which normally infest this insect. A similar form belonging to the same genus occurs on the walnut, and is known as the "Wal-

YELLOW-NECKED CATERPILLARS DESTROYED BY PARASITES.

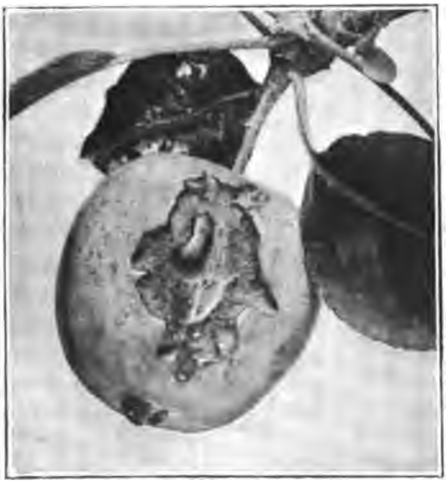


RED-HUMPED CATERPILLAR.

nut Worm." The larva, however, can be readily distinguished from that of the apple worm, as it is darker in color, larger and covered with whitish hairs. There are also three narrow stripes down the back.

The Red-Humped Caterpillar (Oedemasia eximia). This is another caterpillar that frequently occurs in the same locality as the Yellow-Necked Caterpillar. It is quite injurious, and sometimes does considerable damage in neglected nurseries. The head of the larva and a prominent hump on the back of the fourth segment is of a bright coral red. The caterpillars feed in clusters or in colonies in much the same fashion as the Yellow-Necked Caterpillar. The adult moth has a wing expanse of about one and a half inches, being brown in color, marked with darker brown. This caterpillar, like the Yellow-Necked Caterpillar, may be controlled by gathering and destroying the colonies of larvæ wherever they occur, or by using any of the arsenical preparations as a spray.

The Palmer Worm (Ypsolophus pomatellus). This is a native species that has been called the "Junior Canker Worm," owing to the fact that its work on the foliage of the apple very closely resembles the work of the Canker Worm. The eggs are probably laid in the spring of the year, though I do not know of anyone who has ever observed the eggs of this species. The young caterpillars eat not only the leaves, but make rather a characteristic injury on the fruit. The larva is brownish-green in color and has two narrow dorsal and two broad lateral whitish stripes. The head is light brown in color. The pupa condition is passed attached to the leaves, and lasts for about ten days, the adult moths emerging about the last of June or the first of July. The adult moth lives over the winter and deposits the eggs in the spring of the year, as indicated above. I have seen orchards in northern Indiana that were practically stripped by this insect. Any arsenical spray will control them, and it is probable that the regular



Work of the Palmer Worm on Fruit.

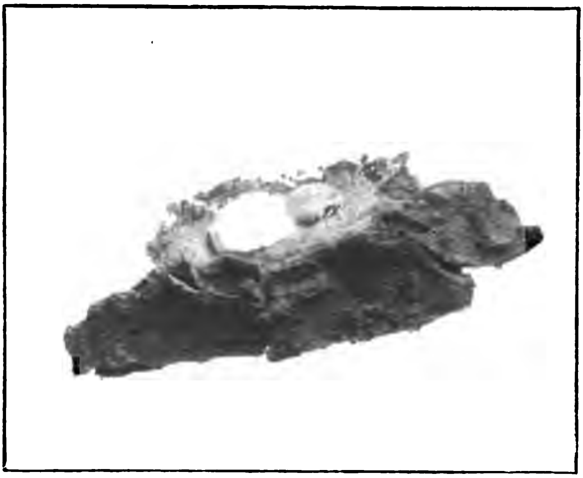
sprayings for the Codling Moth will be all that is necessary to keep the insect under proper control. One of the most curious things about this particular moth is the fact that it has such marked "ups and downs" in the matter of numbers. It is a well-known fact that most insects are controlled by various parasites, so that they do not occur in injurious numbers as a rule for more than one or two seasons in succession. The Palmer Worm has been rather notorious for its very definite period of injury, and there are several notable cases on record of the appearance of this form. These cases are about fifty years apart and extend back for the last one hundred and fifty years or more. Some writers have even held that the Palmer Worm was responsible for the destruction of the trees which it is thought formerly covered the western plains. This is probably mostly imagination, but shows the importance with which some writers have regarded this form.

Apple Aphis (Aphis mali). The eggs of this destructive species are laid on the young twigs in the fall of the year, and may be found throughout the winter. They are usually found in a depression on the twigs, and frequently may be found sheltered in the cavities between the bark and the stem. The eggs are very minute and of a shiny, glossy, black color. They hatch at the appearance of warm weather, and the young migrate to the leaves, where they begin feeding, usually on the under side, causing the leaves to curl under. This makes an exceedingly difficult form to reach with any spray solution. Where the pest occurs I would advise using some mild contact insecticide, such as miscible oils at one to thirty, or a strong tobacco solution, or whale oil soap. This particular louse is frequently controlled by a number of dif-

The eggs of the Apple Louse (Aphis mali) are often laid around the buds on the small twigs. Those shown in the picture are magnified about eight diameters.

ferent parasites, notable among which are the lace-winged flies, a description of which is found elsewhere in this report. The larva of the Snowy Tree Cricket frequently does considerable good in keeping down the numbers of this pest. In this way it doubtless pays for the slight injury caused by the deposition of the eggs of the cricket in the young twigs.

The White-Marked Tussock Moth (Hemerocampa leucostigma). This is a familiar native moth, and one which does extensive damage to both shade trees and orchards. The caterpillar may always be recognized by the vermillion color of the head and the series of bright spots along the back near the tail. It is also characteristic for the caterpillar to have four conspicuous tufts of white hair along the back.



Female Tussock Moth laying Eggs.

When the caterpillar reaches its full growth it weaves a loose cocoon, into which the hairs of the body are interwoven. The female of this moth is wingless, and as a rule leaves her eggs in a mass on the outside of the cocoon from which she has just emerged. These cocoons are usually situated in some sheltered place on the trunk of the tree on which the female has been feeding, or an adjacent building. It is a common thing for this moth to weave its cocoons under the projections caused by the overlapping weatherboards of a house.

The insect winters in the egg state and the young hatch early in the spring. As a rule there are three broods of the Tussock Moth in this locality. The eggs of the third brood carry the form over the winter. Occasionally these eggs develop prematurely in the fall of the year when the weather is warm and favorable. Near Vevay, Indiana, in November of 1909, I found the young of this moth that had recently emerged from an egg mass on an apple tree. The young caterpillars would, of course, have been killed by the first approach of cold weather. Since it is necessary for the young caterpillars to crawl up the trunk of the tree in order to reach the foliage, they can be prevented from doing much damage by banding the trees with some sticky material, which will prevent their gaining access to the branches. Spraying with arsenate of lead or with any other arsenical preparation would, of course, be effective, as they are typical leaf-eaters. One of the most effective means of control is to gather the cocoons in the winter time, when they are conspicuous and readily seen. A few seasons ago this moth became very destructive in Indianapolis. The school children were interested in the matter of collecting and destroying the cocoons bearing the egg masses. The movement became quite extensive, and as a result the moths were almost exterminated in sections of the city where they had been very numerous.

Tent Caterpillar (Clisiocampa americana). This exceedingly destructive caterpillar winters in the egg state, and often as many as three hundred eggs occur in a single cluster. The young caterpillars hatch in the early spring, feed on the opening leaves and frequently do great damage to a tree. The larvæ build characteristic nests or tents in which they remain except when they emerge for feeding. These nests frequently reach considerable size and are conspicuous and unsightly. The full-grown caterpillars are dark in color with bluish-yellow spots. Down the back there is a continuous line of white. The larval life is something over a month and the insect then enters the pupa stage, in which it remains for a little less than a month, the adults emerging in the early summer and laying their eggs on the twigs for the next year. The Tent Caterpillar is a native American insect and its original food was doubtless the Wild Cherry, which it still attacks very frequently and usually in preference to the apple. It sometimes occurs in very injurious numbers in apple orchards, however, and is a form which must be watched for and fought vigorously when it appears. In speaking of the first American apple tree Thoreau says, "The Tent Caterpillar saddled her eggs on the very first twig that was formed and it has since shared her affection with the Wild Cherry."

Being an active leaf-eater this caterpillar is generally controlled by any arsenical spray. In orchards that are regularly sprayed for the Codling Moth there will be little to be feared from this form.

Forest Tent Caterpillar (Clisiocampa disstria). This is similar to the Apple Tent Caterpillar, but the larva may be distinguished by the fact that the white line down the back is broken into a dorsal row of diamond-shaped spots. The egg masses may also be distinguished from the egg masses of the Apple Tent Caterpillar. In each case the eggs are laid in a mass surrounding the twigs. In the case of the Forest Tent Caterpillar these egg masses are more nearly cylindrical and with rather abrupt ends, while in the case of the Apple Tent Caterpillar the egg masses taper somewhat at the ends, making a spindle-shaped mass.

Fall Webworm (Hyphantria cunea). The larva of this moth is familiar to nearly everyone as being a common pest on many of our native and cultivated trees. The insect is, perhaps, most common on the Wild Cherry, where its large, ugly webs may be found season after season. In habit the Fall Webworm is similar to the Tent Caterpillar, though the latter may always be recognized as a distinct form simply bcause of the difference in season. The Fall Webworm occurs late in the year and builds a web as soon as the caterpillars hatch from the eggs, and does its feeding in and around these webs. The webs are persistent on the tree throughout the winter as a dirty tangled mass of dead leaves and insect remains loosely bound together with coarse silk.

The Fall Webworm passes the winter in the pupa stage in a loosely-made cocoon, sometimes within the borders of the old web. Where the form occurs on cultivated trees the webs should be destroyed with a torch and any living caterpillars which fall to the ground should be destroyed. A serviceable and simple torch for this purpose consists of a good-sized corncob soaked in coal oil and fastened to the end of a long pole.

The Bag Worm Moth (Thyridopteryx ephemeraeformis). This is one of the most curious insects which we have. The young larvæ hatch from the eggs in the spring and at once make for themselves a small bag which they carry around with them for the rest of their lives, adding to it as their increased size may require.

When the insects reach their full size, usually late in the summer, they attach this bag or cocoon to some convenient twig and enter the resting stage.

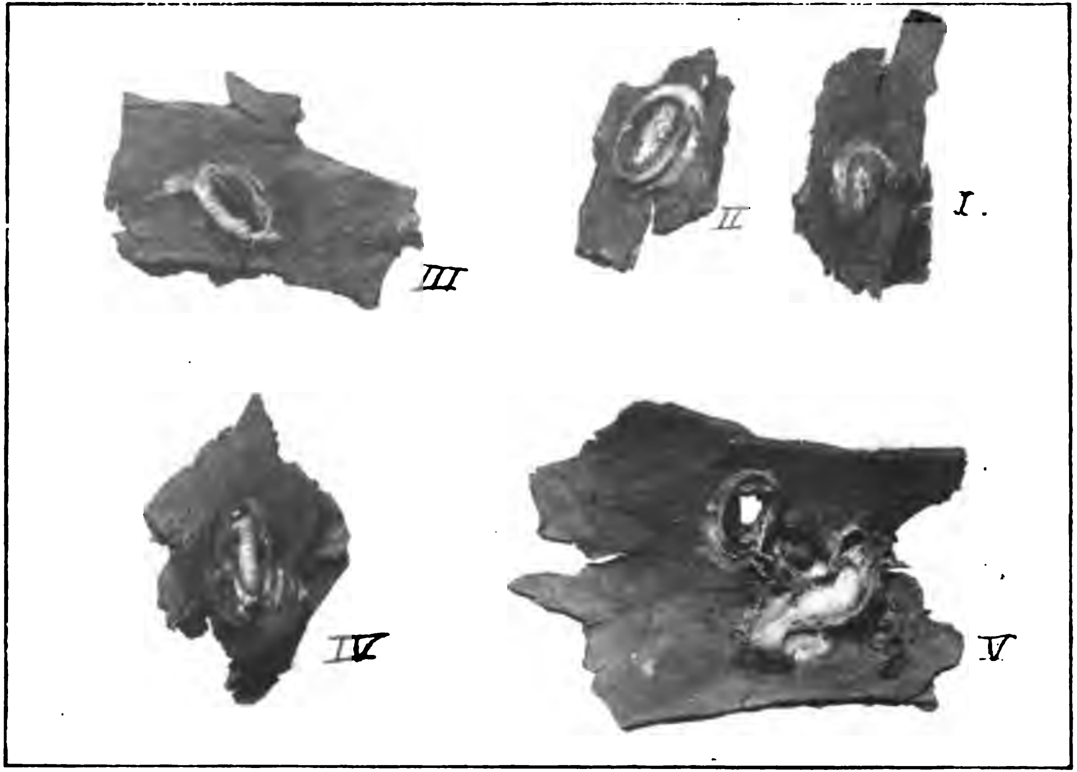
In the case of the female there are no wings developed, and the adult insect never even leaves this cocoon, the eggs being laid inside of that structure. This gives us the exceedingly curious condition of an insect passing the winter in the egg state inside of a cocoon. In orchards that are sprayed for the Codling Moth the Bag Worm will be taken care of as a mere incident to the destruction of the fruit infesting species.

Cigar Case Bearer (Coleophora fletcherella). This is one of the most interesting among the minor insects that affect the apple leaves. The small caterpillars feed openly during the summer and in the fall of the year form a curious crescent-shaped case in which they pass the winter, remaining all the time as larvæ. In the spring the small larva, still carrying the case with it, makes its way to the green leaves and out of a leaf makes its permanent case, or bag, of a peculiar cigar shape. In this new case the insect reaches its full size, and while it is growing, in the spring of the year, is the period of its greatest injury. Being an active leaf-eater, it can be controlled in any orchard that is sprayed for the Codling Moth. The adults emerge from about the middle of June to the middle of July, and the young caterpillars shortly thereafter.

Leaf Crumpler (Mineola indigenella). This insect is somewhat similar to the last, but is decidedly larger, and its work is accordingly of greater importance to the orchardist. It is also a more common occurrence throughout Indiana than is the Cigar Case Bearer. The life history is very similar to the preceding, and the same is true regarding the control of the pest in orchards that are regularly sprayed for the Codling Moth. Occasionally the winter nests of this and the preceding insect are found on nursery stock, and, of course, any young trees found to be so infested should be cleared of the larvæ cases before being set out in the orchard.

Apple Bucculatrix (Bucculatrix pomifoliella). This small moth issues from its cocoon in the early spring, lays its eggs on the leaves of the apple and the young larvæ are for a time leaf miners, working on the inside of the leaf. In this situation they will be untouched by any spray solution for some time. As they grow, however, they emerge to the surface of the leaf and feed openly where they would be reached by any arsenical spray. When the young caterpillars reach their full growth they are not quite one-half an inch long. They then make a very pretty little cocoon about the shape and size of a grain of oats. This cocoon is fastened to the apple twigs and in it the moth passes the winter, the adult emerging the next spring. There is but one brood of the moths each year.

The Bud Worm (Tmetocera ocellana). While this insect is called the Bud Worm, it has a very extended range of seasonal in-



SCALES OF BARK SHOWING THE WINTERING OF CODLING MOTH.

I—Winter cocoon. II—Winter cocoon. III—Cocoon opened to show pupa. IV—Opened to show larva.
V—This bit of bark was drilled through by a Downy Woodpecker and the larva was eaten.

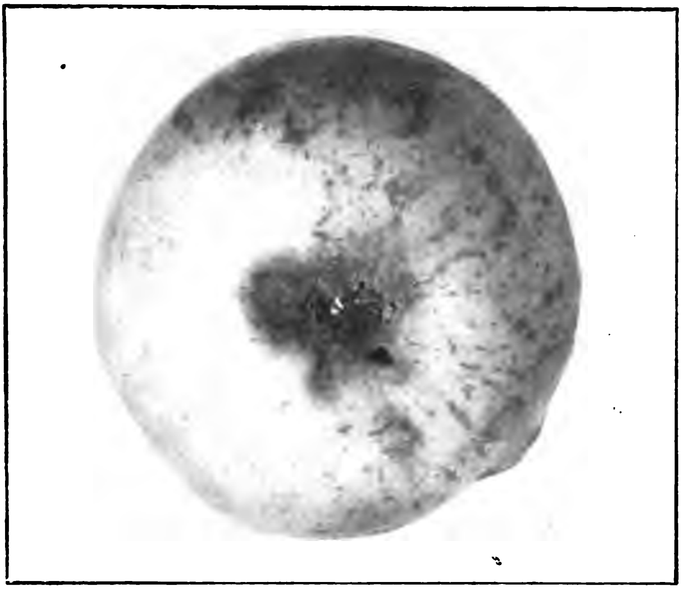
jury. The adult caterpillars hibernate through the winter and appear in early spring at about the time the buds are opening, being of the very earliest of the leaf-eating caterpillars to appear. They reach their full growth late in the spring, and the adult forms emerge and lay their eggs early in the summer. The tiny caterpillars feed until late in the summer or early autumn, when they build a silken web in which to pass the winter—usually in the cracks of bark or in the crevices between a bud and a twig. If the first orchard spraying for the control of the Apple Scab is made with a poisoned fungicide it will probably do effective work in preventing injury by this insect. The adult moth is about the size of, and very closely resembles, the Codling Moth.

INSECTS INJURING THE FRUIT.

The Codling Moth (Carpocapsa pomonella). The Codling Moth is by far the worst enemy of the apple in America. Practically everyone is familiar with the insect in its larval stage, as it causes by far the largest per cent. of "wormy apples." The insect was introduced from Europe about one hundred years ago, and today is to be found in practically all countries and in all districts wherever apples are grown.

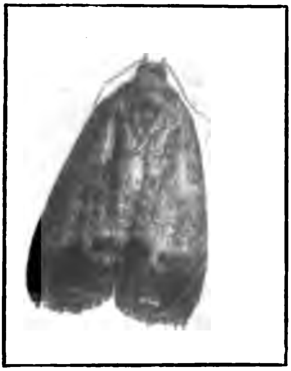
Larva of Codling Moth.

The name Codling Moth is doubtless a corruption of an old English word "quertlying," meaning simply a partly grown apple. As the insect is responsible for the early fall of so many apples in badly infested orchards, the early English horticulturists gave it a name which indicated the kind and size of fruit that it ordinarily attacked. There are some fruit regions in the West where the orchardists have claimed an immunity from this pest, saying that it did not exist and could not exist in their locality. Wherever



ENTRANCE POINT OF CODLING MOTH.

such claims have been made they have usually been based either on ignorance or on the fact that the country was so new that the Codling Moth had not had time to reach there. It is safe to say that there is no section of the world today in which apples can be grown where the Codling Moth cannot exist. Spraying for the control of this insect is just as necessary throughout the much-talked-of apple regions of the West as it is in Indiana, and spraying in Indiana will be just as effective as is the spraying in the West, provided it is done with the same care the western orchardists use.

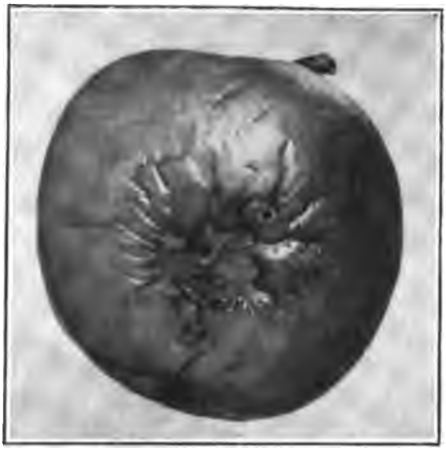


The Adult Codling Moth (Enlarged).

The adult moths appear in early spring and lay their eggs on leaves, or on or near the young apples. These eggs hatch in from ten to twelve days. The eggs are whitish in color and about as big as a pinhead. The larva of this first brood of moths enters the apple usually at the calyx end and feed inside of the apple for some weeks. It then leaves the apple and seeks some crevice in the bark of the tree and enters the pupa state, the adult appearing in early summer. These are responsible for a second brood of moths which, as a rule, enter the apple at the side, preferably where two apples come in contact. The orchardist must determine for himself the time of the appearance of this second brood of moths in order to properly time the application of this second spray. By the use of a simple breeding cage, such as a Mason jar covered with a wire screen, the appearance of these moths can be accurately determined. A few days should be allowed for the eggs to hatch. The trees should also be banded with burlap as traps for the pupa. In this burlap banding will be found many of the hibernating insects which can be destroyed.

The Lesser Apple Worm. (Enarmonia prunivora.) This insect has been much confused with the Codling Moth. It resembles the Codling Moth, both in its appearance and life history and in the character of its work. The worm, or larva, is flesh-colored, and as a rule does not work so deeply into the flesh of the apple as does the Codling Moth, doing most of its injury near the surface. It is characteristic for these worms to work on the surface of the apple, often destroying the skin, particularly around the calyx end.

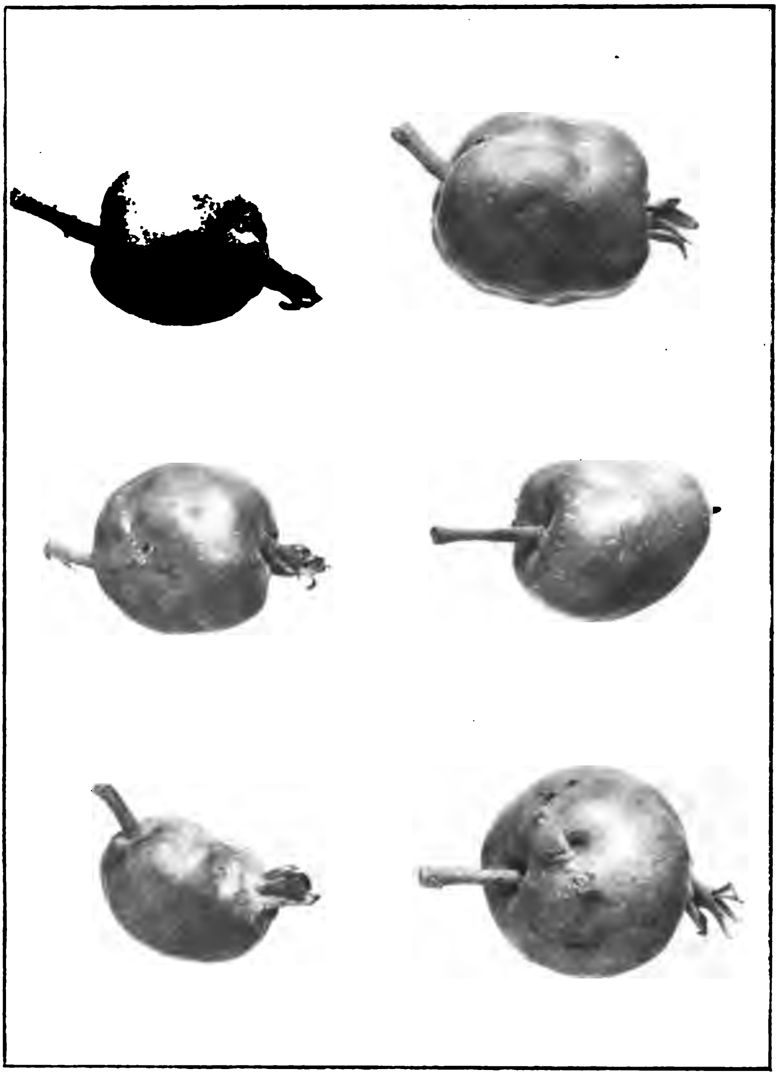
The insect has been called the Plum Moth, but more recent writers have given it the name of the Lesser Apple Worm, as it is found to be more injurious to apples than to plums. The insect is frequently injurious to stored fruit, and it was this fact which first caused it to be particularly noticed as distinct from the Codling Moth. It is supposed to be a native of this country. Its life history is very similar to that of the Codling Moth. Though it has been but little studied, there is doubtless much to learn concerning its habits. It appears, however, that the moth can be largely controlled by the same spraying that is applied for the Codling Moth. In fact, I am inclined to believe that a good deal of the work that has been published on the Codling Moth is based on a study of this insect. The pest is much more



Work of the Lesser Apple Worm.

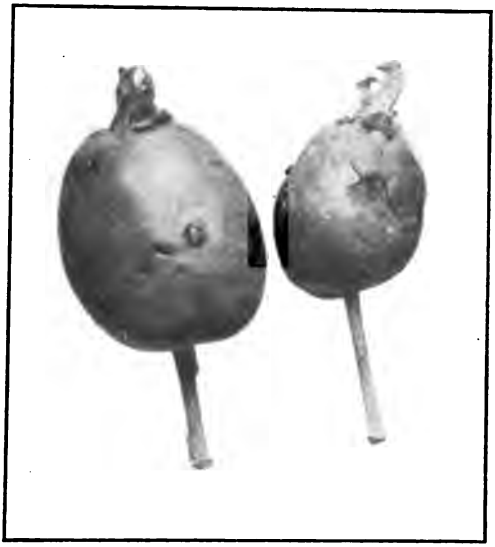
widely distributed than is commonly supposed. In our experimental orchard at Lawrence, Indiana, the Lesser Apple Worm seems to be far more numerous than is the Codling Moth. In fact, the Codling Moth is a rare insect in this particular locality, while the Apple Worm is exceedingly common.

Apple Curculio (Anthonomus quadrigibbus). This is an important insect that has often been confused with the Plum Curculio, which it closely resembles. There are certain points of difference in the two insects, however, which every apple-grower should fully understand. The Apple Curculio is a larger insect, and the four humps which occur on the backs of both beetles are larger than any of the humps which occur on the back of the Plum Curculio. On the Apple Curculio the snout is almost as long as the entire body. This would make it something like three times as long as the snout of the Plum Curculio. In the Plum Curculio the snout is carried hanging down at a right angle to the body, while in the Apple Curculio the snout is carried projecting forward. The marks left on the apple by the two insects are very different. The Apple Curculio lays its eggs in the tissues of the apple, but the mark of the egg puncture is not crescent-shaped, as is the case with marks left by the Plum Curculio. Often only a very slight scar is left by the insect under discussion. Frequently the egg puncture by this species will be practically grown over, and the only effect on the apple will be to cause a distinct dimple in the side of the fruit. The adults of this beetle hibernate through the winter and appear in early spring. They lay their eggs on the young apples almost as soon as they are formed, shortly after the blossoms fall. The beetles continue laying eggs for probably two months, each individual being capable of laying usually more than fifty eggs. These eggs hatch in something less than a week, and the larva is full grown in about twenty days, pupating within the fruit. The pupa condition lasts for a week, and the adult beetles then leave the fruit and are not conspicuous in the orchard until the following spring. They usually hibernate on the fallen leaves and the grass around the tree. This is an insect that is a native enemy of the wild Haw and the wild Crabapple, and it behooves the orchardist to see that no trees of these species remain close to the orchard, as they are fertile breeding places for this orchard pest. Spraying in the spring of the year will possibly destroy some of the beetles, though in feeding, the adult beetles do not eat much exposed tissue to which poison might be applied. They



APPLES DISTORTED BY CURCULIO STINGS.

usually feed by cutting a small puncture in the apple and eating the tissues lying beneath the skin. Unless there chances to be some poison on the particular piece of skin through which they were feeding they would probably not be controlled by the application of any arsenical spray. Where they occur in large numbers it is probable that jarring the trees and catching the beetles beneath the trees in nets would prove effective. This is sometimes effective in controlling the Plum Curculio on plum trees.



Plum Curculio Punctures in Young Apples.

The Plum Curculio (Conotrachelus nenuphar). This is another insect very similar to the Apple Curculio, and it is a frequent source of injury in the apple orchard. The Plum Curculio attacks principally the stone fruits, but very often attacks apples and causes great injury. It has been said that the Plum Curculio causes more damage annually than does the Codling Moth, simply because of the fact that it does not confine its work to one species of fruit, as does the moth. The adult beetle is dark brown in color, about one-fifth of an inch long and with a snout approximately one-third as long as the body. The snout is curved and is carried hanging down at a little less than a right angle to the body of the insect, differing in this peculiarity from the Apple Curculio. The adult insects hibernate through the winter, appearing in early spring to feed on the opening leaves and the young fruit of the apple. The apples are injured both by the punctures made by the beetle in feeding and also by the slits which are cut in the apple and in which eggs are deposited. The eggs are laid through the months of May and June. As the larva grows it sometimes causes the apple to drop. When this occurs the larva reaches its full development in the fruit and emerges to pass the pupa condition in the ground, the adult appearing some time after the first of July. The work of the larva does not always cause the apple to drop from the tree. When the apple does remain on the tree, the young insect, for some reason that is not fully understood, is not able to complete its development, and frequently dies within the apple. Often such an injury is overgrown and leaves only a slight scar on the apple. At other times such an injury results in a streak of hard tissue marking the space in which the larva fed while it was working in the apple. In this it will be seen that vigorous growing varieties will be less subject to injury from the Plum Curculio than are varieties of weaker growth, as varieties which tend to drop easily would be favorable to the development of the insect. The feeding habits of the insect indicate that there will be some measure of success by combating the pests with any poison spray. In orchards that are regularly sprayed for the Codling Moth the injury from this Curculio is comparatively slight. Wherever the insect does occur in injurious numbers it will be well to adopt the plan often followed in plum orchards—of turning chickens into the orchard. The chickens will do more to destroy the beetles which hibernate in the grass, leaves and rubbish on the ground than any anything else.

FUNGOUS DISEASES OF THE APPLE.

EDNA F. M'CORMACK, BOTANICAL ASSISTANT.

A disease is an abnormal condition of a plant usually causing serious damage or premature death. There are many things that will bring about such a condition, as. for example, unsuitable soil, poor drainage, or unfavorable climatic conditions. These are discussed elsewhere in this report. The diseases to be considered in this section are due to another cause, that is, the attack of fungi, and are known as fungous diseases.

A few words concerning fungi and their habits may be helpful to a better understanding of the treatment of the diseases of plants that are of fungous origin. Fungi are plants, usually small, often microscopic, and are very simple in structure. Common examples are moulds, mushrooms, brackets on trees, etc. Fungi differ from other plants with which we are familiar, in that they lack the green coloring matter and in their manner of obtaining food.

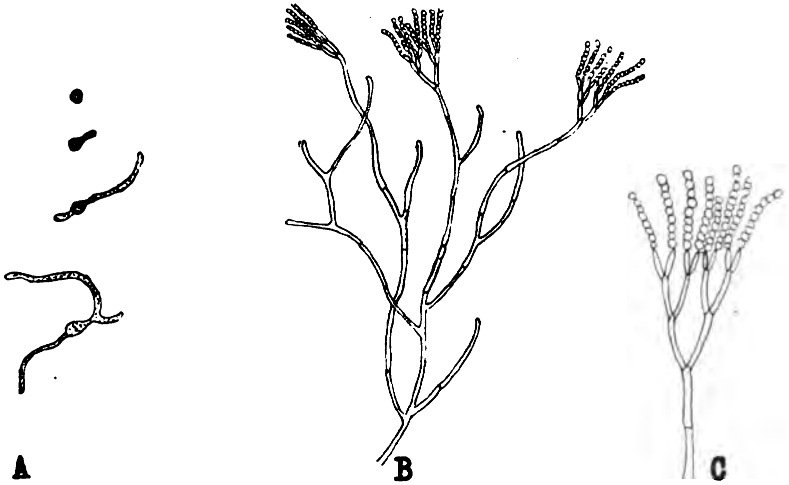
The foods which our common green plants use for growth and nourishment are not taken into the plant ready prepared, but are made within the plant body from raw materials which are taken in from the soil and air. A common food made by green plants is starch. In outline the process is as follows:

Water absorbed by the roots from the soil passes up the stem to the leaves. Here it meets another substance, carbon dioxide, a common constituent of the air that has been taken in by the leaves. These two substances, carbon dioxide and water, are combined to form starch, and entirely different substance. Strange as it seems, the green coloring matter and sunlight must be present or starch cannot be made. The mineral matter which is taken in by the roots is used in the making of more complex foods. Fungi lack the green coloring matter and are unable to make even the simplest of plant foods, and must depend upon the food which has been made by green plants for nourishment. When fungi feed upon living plants they kill the cells upon which they feed, clog up the food and water passages, or in some other way interfere with the work of the plant. The result is a weakened condition that we term a disease. Such fungi we call parasites. The fungi living upon dead tissues are called saprophytes, to distinguish them from the first class. An examination of the common blue mould, found upon preserved fruit, will give one a very good idea of a fungus. Examining this mould carefully it will be found to be a mass of silky, cobweb-like threads. This is more evident if examined with a hand lens. If more highly magnified these threads will be found to be a branching, intertwining mass of very minute tubes, with delicate walls. This is what is called the "plant body," and corresponds to the root, stem and leaves of our more complex plants. The work of the plant body in this case is simply to *absorb* the food already prepared for it, and this system of thin-walled tubes is admirably fitted for the work. In the case of the fruit mould, the food is the sugar in the preserved fruit. Such a fungus would be called a saprophyte.

When a fungus is living upon the substance of a plant, the fungous threads either grow over the surface and send absorbing threads down into the plant or the whole fungus may live below the surface in the plant tissues. Areas of dead cells killed by fungi are called fruit spots, leaf spots, rots, etc., depending upon the part attacked. Such fungi are true parasites. Fungi do not form seeds, but have a much simpler, although very effective, means of reproducing themselves. They form microscopic bodies very simple in structure called spores. These spores are produced in great numbers and are borne in a position at or near the surface of a plant, so that they may be easily distributed. Like a seed, each spore is capable of forming a new plant. These spores may be borne in various ways, and the fruit mould illustrates one of the most simple. Minute rounded bodies are cut off from the tips of the fungous threads. These little bodies are the spores, and at first they hang together in chains, presenting a fan-like appearance when seen through the microscope. (See illustration.) As these spores mature they separate and are carried off by the air ready to start a new fungus growth should they alight in favorable places. To the naked eye a mass of these spores appears as a blue-green powder over the surface of the mould and gives the fungus the name of blue mould.

Another fungus forming spores in this way is the one causing the brown rot of cherries, peaches and plums. The brownish powder over the surface of the rotted fruit is a mass of spores.

There is another way of producing spores—the way most commonly found among fungi causing plant diseases. The spores are borne in tiny cases, formed by the massing together and interweaving of fungous threads. These cases or fruiting bodies, as they are often called, are developed on or just below the surface of the plant on which the fungus is growing. Spores are formed in great numbers in these little chambers, and when mature escape through an opening in the top. We have many examples of this on rotted fruits and on twig cankers. Good examples are found on apples attacked with the Black Rot fungus and the Blotch. Without the aid of a hand lens they may be recognized as small elevations or pimples, somewhat smaller than a pinhead, scattered over the surface of the diseased spot. The slits or openings in the top through which the spores escape may often be seen. A section through one of these fruiting bodies or pustules is shown in the illustration as it appears through the miscroscope. Spores which are formed to carry the disease over the winter and start new infection in the spring are protected in these pustules.

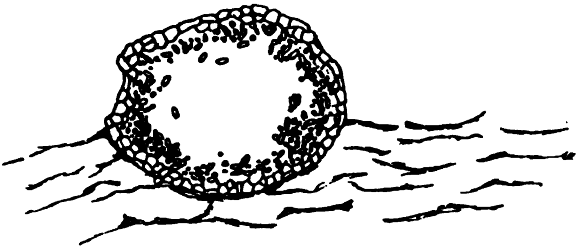


BLUE MOULD ON PRESERVED FRUITS (MAGNIFIED).

A—Growth of fungous threads from spores. B—Fungous threads bearing spores. C—Enlarged spore-bearing branch showing spores produced in chains at the tip of the branch.

When we understand how small and light spores are and in what great numbers they are produced, it is not difficult to understand why a disease, when it once appears, spreads so rapidly, and why a whole orchard or field becomes infested in so short a time. As spores are always borne at or near the surface of the plant, as soon as they mature they float off into the air and are carried by air currents from one place to another, or they may be washed by rain or dew, or blown by sprays. Another common way is for them to cling to the bodies of insects or birds, and thus become distributed. Whenever they alight in situations where food is available they begin growth. All of these things working together account for the rapid spread of the disease from one plant to another and even from one orchard to another.

In attempting the control of a disease, it is with the spores that we deal mainly. A fungicide is effective in killing fungus spores whenever it comes in contact with them. Spraying a plant with a fungicide kills the spores that have alighted on it and thus prevents their entrance into the plant tissues. It also destroys the spores as they mature. It is not able to enter into the plant and kill the fungus after it has gained a foothold, nor is it able to kill the spores in the pustules before they ripen and are exposed. From this it can be seen that one must know at what time these spores ripen in each disease in order to have the most satisfactory results from spraying.



A Section through a Spore Pustule (magnified), showing Heavy Wall and Spores Enclosed.

There are a few points to be remembered in the treatment of all fungous diseases. The disease must live over the winter in some dormant stage. Usually spores that escape and start the disease in the spring are protected in pustules of some sort on the diseased material. For this reason all such material should be removed from the orchard at the end of the growing season. Fallen leaves should be raked up and burned. The decayed fruit which remains hanging to the tree should be removed by all means, as this is one of the principal sources of infection in all diseases causing fruit rots. The rotted apples which have fallen to the ground can be quickly and effectively cared for by turning a few hogs into the orchard. Another place where the disease may hold over the winter is in the twig and branch cankers. Pruning of cankered branches will do much to lessen the source of infection, and, wherever practical, the diseased limbs and branches should be removed. Large trunk cankers may often be treated successfully by peeling or cutting out diseased portions and painting over the wound.

In the following pages we have attempted to describe the characters of each disease as clearly as possible, so that it may be recognized as it is met in orchard or vineyard. In the advised treatment we have given to the agriculturist what has been found by investigation and experience to be most successful. If there is any doubt as to the identity of a disease, samples may be sent into this office for identification and any questions concerning treatment will be gladly answered.

THE PREVENTION OF PLANT DISEASES.

From the foregoing discussion it will be seen that the treatment is preventative rather than curative. If the fungus gets a foothold all that can be done is to check its further spread. The most effective means of keeping fungi from the orchard is to keep the trees in such a state of health that they can resist the attacks of disease-producing organisms.

It was stated that disease is an abnormal condition of the plant. This is another way of saying that the normal condition is a state of health and fruitfulness. Agriculturists throughout the country are rapidly coming to the realization of the fact that to keep them in a normal, healthy state, they must know more of plants and consider their needs intelligently. It is the business of the farmer to study the plant, discover the needs and supply the lack whenever it lies within his power.

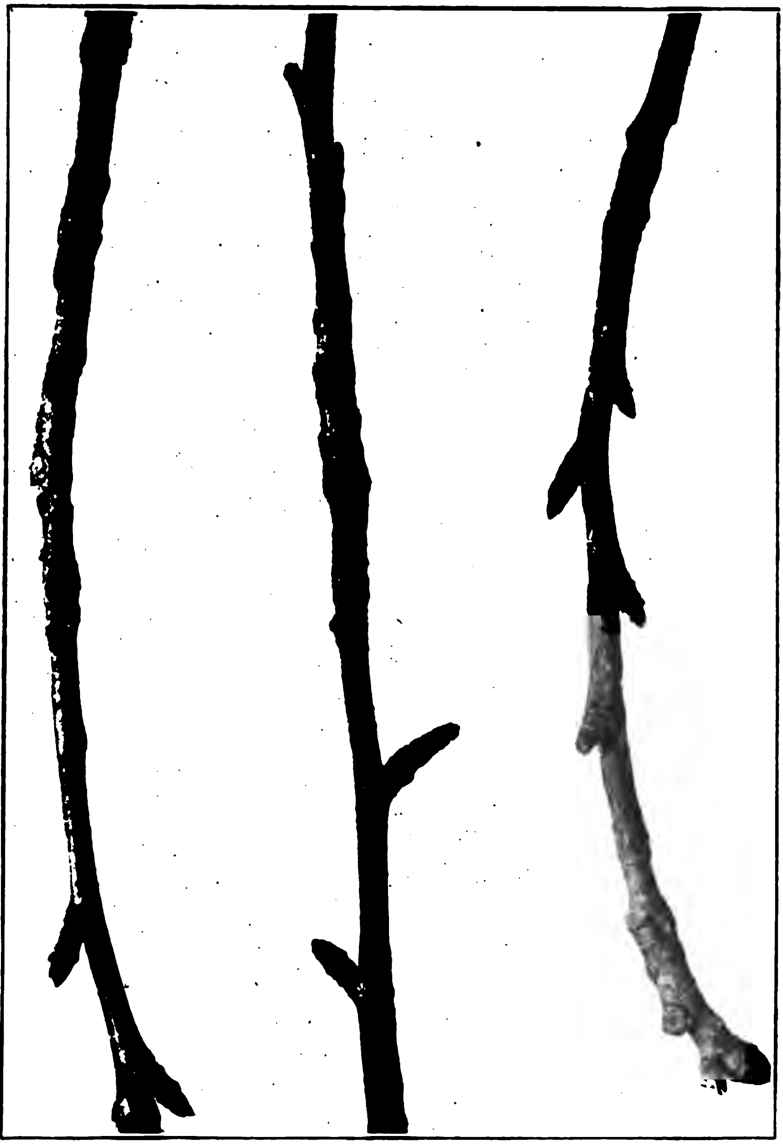
For example, it must be kept in mind that the first and principal need of plants is proper nourishment, and that the food is made by the plant itself from materials it gathers from its surroundings; that each part of the plant is fitted particularly to do some part of the work of gathering together the materials from which the food is made or has some part in the making of the food. Each part must be doing its work efficiently and the plants must have access to the materials from which the food is made.

The roots absorb moisture and dissolved salts. It should be seen that they are in a healthy condition when the trees are planted, and care should be taken that they are in no way injured in planting. Plenty of space should be allowed for them to spread out in the soil, that they may gather plenty of water and come in contact with fresh soil. If there is a deficiency of available mineral salts, the use of fertilizer will supply the lack. It may be stated here, however, that there is a mistaken notion among many that the so-called "plant foods" will supply the lack in all weakened conditions. This is not true. The use of fertilizers has its place, but it is only to aid in furnishing the required amount of mineral salts necessary for food making, and is absolutely of no use when the trouble is with some organ of the plant. Water, another raw material, can be held in the soil for the use of the plant, by proper cultivation.

The stems conduct moisture and minerals to the leaves, and hold the foliage to the light and air. It also conducts the food from the leaves to parts of the plant where it is to be used or stored. The food and water conducting tubes are not in the center of the tree trunk, but are quite near the surface, and care should be taken that there are no wounds or cuts made in the trunk or branches to interfere with the free passage of materials, or to allow the entrance of disease-producing fungi or bacteria that will grow in the stem and clog up the passages.

The leaves gather the gases that are necessary from the air and they, are also the principal food-making organs. Without the leaves practically all food-making ceases. This is the reason for fighting "leaf diseases" so vigorously. Many of the fungi living on leaves, such as Rust and Apple Scab, kill large areas of food-making cells, and interfere with the passage of materials in the veins, and the leaves die as a result. Loss of leaves early in August means the loss of a great deal of reserve food that the leaves would have made during August and September. Several seasons of early leaf fall mean a weakened condition. The great importance of leaves should be kept in mind when pruning. Many trees are so closely cut back that there is not enough foliage to make the amount of food necessary for even the immediate use of the plant.

This is not the place for a detailed account of orchard care and the points that have been mentioned are given only to show wherein a knowledge of plants will guide one to the intelligent care of the orchard, and it cannot be too strongly stated that intelligent care means health and resistance to disease.



TWIG CANKERS CAUSED BY BLOTCH FUNGUS.

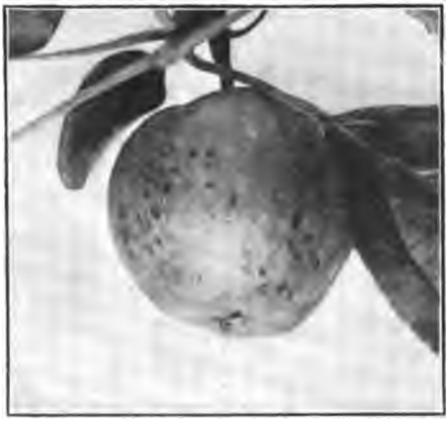
APPLE BLOTCH.

(*Phyllosticta solitaria.*)

Early in the summer of 1909 this disease was reported by one of our inspectors as very common in the orchards in the southern part of the State. At this time the disease had never been sent into the laboratory and nothing was known concerning its prevalence or destructiveness. In fact there was no published record of its occurrence in the State. Inspection work was begun to determine its distribution and since that time it has been found in nearly every county south of Marion. It has been found, not only in orchards but on nursery stock, in several places. While it is present in practically all of the counties in the southern half of the State, it is in the extreme south that it is the most destructive. The two tiers of counties bordering the Ohio River suffer the most from the disease. The failure to report the disease seems to be due to confusing it with Apple Scab.

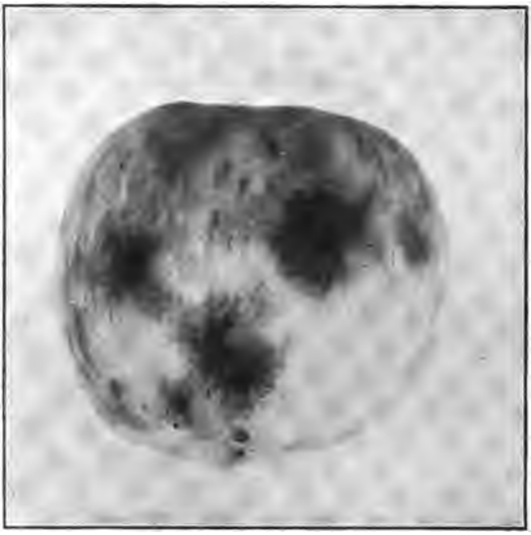
APPLE TREE SHOWING LIMB KILLED BY APPLE BLOTCH TWIG CANKERS.

The disease causes twig cankers, fruit blotches and leaf spots. The cankers are usually found several years before the disease makes its appearance on the leaves and fruit. These cankers are very characteristic and are easily recognized. They start early in the spring as small purple spots on small twigs and water-sprouts. As the spots enlarge the center of them becomes cinnamon-brown and very soon becomes dotted over with small black pustules bearing the spores. Very soon cracks will appear along the margins of the cankers and often the whole canker will peel off, exposing the wood. This gives the twigs a rough, shaggy appearance. Although the individual cankers are not large they are very numerous, and commonly twigs are found entirely covered with them. The fungus lives over the winter in cankers and continues growth the following spring. By the first of May the cankers have increased considerably in size, as is evidenced by the purple color of the newly-infested area. This margin around the old canker is in many cases as much as one-fourth of an inch in width. Spores are at this time being discharged from the old cankers and the pustules are forming on the new cankers and the margins of the old cankers. Spores from these new cankers will mature sometime during the summer and aid with the spread of the disease during the growing season. In severe cases of the Blotch large limbs are entirely killed by the twig and branch cankers.



Fruit Blotch when it First Appears on Young Fruit.

The disease was watched very closely during the past season, and on June 25th the first fruit blotches were found near Indianapolis. At this time they appeared as very small light-brown flecks. Even at this early stage spore pustules began to appear. They may be recognized as one or more very small elevated points in the center of a spot. The spots enlarge, become darker in color, but keep the irregular or fringed margins, this being a character by which one may easily recognize the disease on the fruit. The spore pustules continue to appear over the surface of the spot throughout its growth.



Apple Blotch Fruit Spot.

Mature spots vary in size with the variety of apple attacked. On some varieties, usually the light colored, they may remain small and appear in large numbers. On others, usually the red-cheeked, they are fewer in number and larger.

The spots do not extend deeply into the apple and the growth of the healthy tissue beneath them often causes deep cracks across the blotched surface. Very old spots may become quite sunken and lose their fringed outline. The disease is readily recognized at all times, however, as up to harvest time all stages, from the small light brown flecks to the deep brown, sunken spots, may be found on the same apple.

Apple Blotch Leaf Spot.

The effect of the Blotch on the fruit is to make it unsightly and often unsalable. It is also unfit for storage, as the spots on apples at picking time will continue growth and the cracking allows the entrance of rot-producing fungi. No *new* spots appear in storage, as the spore-bearing pustules cease producing spores before the end of the summer.

There is a leaf spot caused by the Blotch fungus, but this has not as yet been found to be of any economic importance in the State. It is a very small spot, less than one-sixteenth of an inch in diameter, and light yellow in color. It usually bears one or two minute pustules in the center of the spot. It is a spot that would not be noticed by the average observer.

Treatment.—The spores are discharged from the pustules on the twigs from a month to five weeks after the petals fall. This causes the first outbreak of the disease. An application of Bordeaux or lime and sulphur made at this time will prevent the germination of the spores. This is the most important of all the applications in the control of the disease, and the delay of a few days in the making of it may result in failure in controlling the disease. Three other applications in all should be made. These correspond to the first three for Bitter Rot. In other words, the two diseases may be controlled by the same treatment after the first treatment for Blotch. For this treatment see Bitter Rot of the apple.

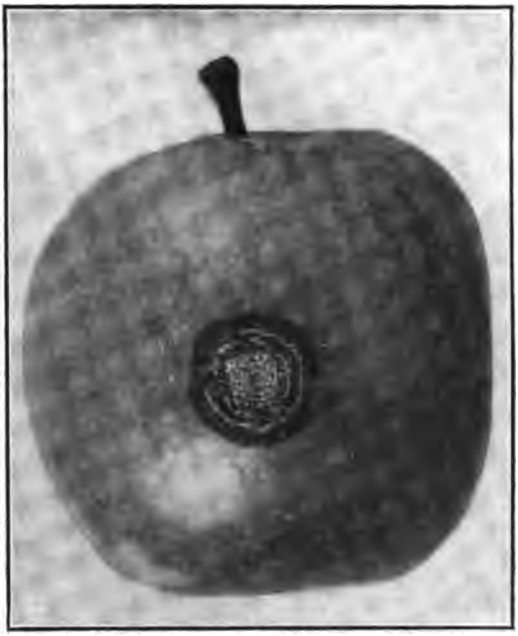
Pruning is of great importance in controlling the disease, as when this is neglected the cankers accumulate on the twigs and are the means of causing the severe outbreaks of the disease in the spring.

BITTER ROT OR RIPE ROT.

(*Glomerella rufomaculans.*)

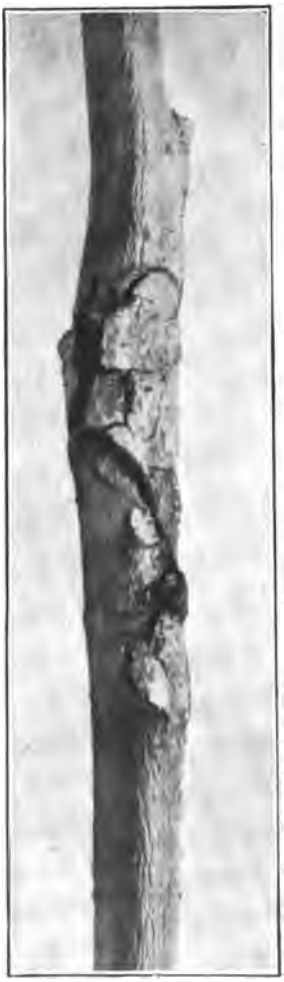
This is a disease of the apple appearing in late summer and fall, usually in August and September, although it often comes in July, and has been reported as early as June. Because of its usual late appearance it has been given the name of Ripe Rot in many sections of the country. The disease starts earlier and causes most severe losses after a hot, wet season, as heat and moisture are necessary to start the growth of the fungus that causes the disease. After the fungus gains a foothold, dry weather does not interfere materially with the progress of the disease. During the past season there was a great deal of rain in the southern half of the State during the month of July, and in this part of the State the disease started early and caused considerable damage. The first reports of the rot on the fruit came in during the first two weeks in July.

Bitter Rot causes a fruit rot and a twig and branch canker. The rot on the fruit is not a rot in the ordinary sense of the word, as the diseased tissue is dry and leathery and not soft and pulpy, as we usually think of a rot. Bitter Rot on the fruit first shows itself by very small brown spots appearing over the surface. These vary in number from one to many, but usually there are not more



Bitter Rot Fruit Spot. Pink masses of Spores in concentric circles.

than half a dozen. These brown specks enlarge, forming circular dark brown to black spots with sharply defined margins. The spots become sunken and are dry and leathery in texture and bitter in taste. This "dry rot" extends deep into the apple, often reaching the core. When the spot is about an inch across a ring of small black dots appears beneath the surface. These develop into tiny raised points and finally burst through the skin of the fruit. The spores are born in these pustules and are discharged through the opening in pink creamy masses or minute threads. These masses run together and dry, forming a crust which becomes dull red in color and when very old becomes gray. As the spot increases in size more rings form outside of the first. These concentric rings of pustules discharging the spores in creamy masses is a very distinctive character by which to recognize the disease. This is shown in the accompanying illustration. If a little of the creamy material discharged from the pustules is put in water and examined under the microscope it is found to consist of millions of tiny colorless spores. The substance holding them together quickly dissolves in the water and leaves the spores floating free. This helps us to see what happens in the orchard. Rain or dew dissolves the substance holding the spores in a mass and they are washed or blown in spray to other fruit or twigs, on which they begin growth and thus start the disease. The whole fruit may become rotted either from the increase in size of one spot or the growing together of many. Completely rotted apples dry and shrink, forming what we call "mummies." Rotted fruit usually falls to the ground, but often "mummies" are covered with the spore-bearing pustules and the spores contained in them are able to live over winter and escape in the spring, as they did the preceding summer. For this reason as many "mummies" as possible should be removed from the trees in the fall after the leaves have fallen. A few hogs in the orchard in the summer will quickly rid the ground of the rotted fruit as it falls.



Bitter Rot Branch Canker.

During the summer of 1901 R. A. Simpson, of Vincennes, Ind., observed that an area of infected fruit was just beneath a wounded and rough looking branch. He observed this to be true in a number of cases. Closer examination showed that the wounded portions of the branches were covered with pustules which exuded pink waxy-looking masses resembling the masses of spores exuded from pustules on the fruit. More extended investigation was made by the Illinois Experiment Station, for whom Mr. Simpson was working at that time, and confirmed the observations, and it is now a well-known fact that this wound canker is a stage of the Bitter Rot disease. The fungus attacks limbs as well as fruit and the spores from the pustules on these cankers are the chief means of spring and summer infection. It is here principally that the spores live over winter and from here they are washed during the following summer, as is shown by the presence of diseased apples mainly below cankered limbs. The canker may be described as a blackened depression usually on the under side of twigs and small branches, and are often found encircling the base of a twig. The bark on the cankered spot clings closely to the wound and causes cracks to appear across the canker. A callous forms around the edge of the depression, making the canker more noticeable. The wood beneath the canker becomes dead and discolored. Cankers originate by spores lodging in wounds and bruises and germinating after they have gained entrance to the tissues of the branch.

Treatment.—Repeated experimental work and extensive practice by fruit growers has proven beyond doubt that Bitter Rot can be effectively controlled and the loss in treated orchards can be reduced to two or three per cent. As this fungus lives over the winter in cankers and mummies, and as it has been shown that the infection starts from here in the spring, the first step in eradication is to remove all mummies and as many twig cankers as possible after the leaves have fallen in the winter. After this is done the next step is to prevent the spores from developing. This is done by spraying either with Bordeaux mixture or lime and sulphur. The important thing to keep in mind, if this work is to prove effective, is that all spraying must be thorough. All parts of the tree must be reached by the spray. In cases where one side of the tree has not been sprayed a decided difference in the quality of the fruit on the two sides has been found, the unsprayed side being decidedly more infested with Rot. Another point equally important is spraying at the proper time. Very successful results have followed applying the spray six weeks after the trees bloom and making four applications at intervals of two weeks. In especially bad seasons make two additional sprayings as a safeguard.

The following is an excellent combination treatment for Scab and Bitter Rot:

This is a vigorous treatment and it is not often that the well-kept orchard will have to be sprayed as many as eight times. The outline is based on control treatment in severely infested orchards.

1. Make the first application of Bordeaux or lime and sulphur just before the opening of the flower buds. It is important that this application be made at the proper time.

2. The second application as soon as the petals fall.

3. A week or ten days later.

4. An application forty to fifty days after the petals fall.

5. After this make applications at intervals of two weeks until a total of eight applications have been made. In seasons when the disease is not particularly destructive longer intervals may be left between later sprayings.

If infection has begun before any spraying has been done the destruction may be lessened by making two applications with only an interval of a few days. After this the intervals may be lengthened.

It is not often that the well-kept orchard will have to be sprayed as many as eight times. The above outline is based on control treatment in severely infested orchards.

BLACK ROT OF THE APPLE.

(*Sphaeropsis malorum.*)

This is a fungus which causes a very common fruit rot, a destructive leaf disease and a serious bark canker.

FRUIT ROT.

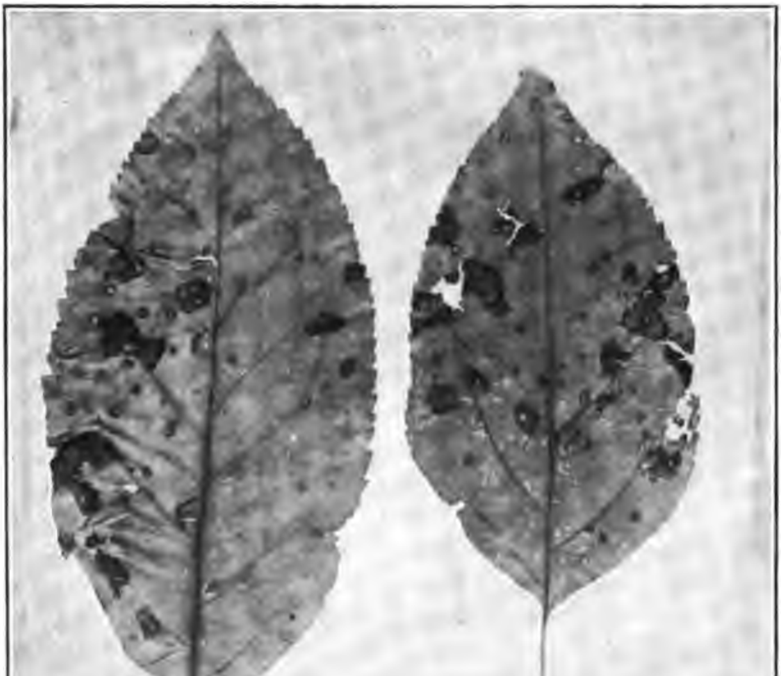
Black Rot is a disease common to apples which have fallen to the ground and commonly appears on storage apples, but is often found on apples hanging on the tree. The first evidence of the disease on the fruit is a brown spot often appearing near the blossom end. This spot rapidly enlarges and the whole apple soon becomes rotted. As the disease spreads over the fruit the brown color becomes darker, often almost black. It is by no means a soft, wet rot. The fruit retains its shape and is only a little less solid to the touch than a hard rubber ball. Conspicuous black pustules appear dotted over the surface. These pustules are most numerous on the oldest portion of the rot and become so closely massed together here that they form a black crust. This, with the dark brown or black color of the rotted fruit, gives the disease the name of Black Rot. The spores from the pustules escape about the time that the fruit is gathered and light on the perfect fruit as it is barreled. Later when the fruit is in storage these spores develop and rotted fruit is the result. For this reason rotted fruit should be removed from the orchard before picking time.

LEAF SPOT.

This is one of the most serious leaf diseases over most of Indiana and is caused by the same fungus that causes the Fruit Rot.

The disease is commonly called "Leaf Spot" and "Brown Spot." The spots appear early in the spring with the Apple Scab

Leaf Spot and by the first of August badly affected trees are entirely defoliated. When the spots first appear they are very small purple dots scattered over the surface of the leaf. But when they mature they are from one-eighth to one-fourth of an inch in diameter, and brown, with purple margins. Neighboring spots grow together, forming large brown patches, but the outlines of the old spots can usually be traced. While the spots first appear before the leaves are full grown, new spots continue to appear all summer. Spore pustules are formed on leaves, but not in great abundance. The leaves fall early and spore-bearing bodies form on the dead fallen leaves. These spores remain over winter and are one means of starting the disease in the spring, but not the principal means. The chief injury done by the Leaf Spot is the early defoliation and the consequent weakening of the tree.



BLACK ROT LEAF SPOTS.

BLACK ROT CANKER.

The canker caused by this fungus has been for a long time familiar to most orchardists, but only recently has it been distinguished from the injury caused by sun scald, which it closely resembles. The disease attacks mostly large limbs and branches, only appearing occasionally on small branches and twigs. The limb disease is conspicuous and can be seen from a distance. The portion of the limb that is diseased appears considerably enlarged. On close examination the enlargement is seen to be due to an abnormal thickening of the bark. The bark is also rough and blacker than the surrounding region, and clings very closely to the wood. In this it is strikingly different from sun scald injury, as in this the bark readily peels from the wood beneath. In severe cases the diseased region girdles the limb, causing its death by stopping the sap flow. In other cases the tree is able to resist the attack of the fungus and it is unable to penetrate deeply, and only scars can be seen where the fungus was working. Spore bearing pustules form on the oldest portions of the diseased bark. They are large enough to be distinguished by the naked eye if the bark is carefully examined. The pustules can also be found on bared wood when the bark has been removed. Spores are produced on fruit and leaves, but the spores in the bark cankers are probably responsible for a large part of the spring infection. The spores live over the winter in the cankers and are discharged in the spring. The spores lighting on limbs start the cankers, and on leaves cause the leaf spots, and later in the season develop on the fruit.

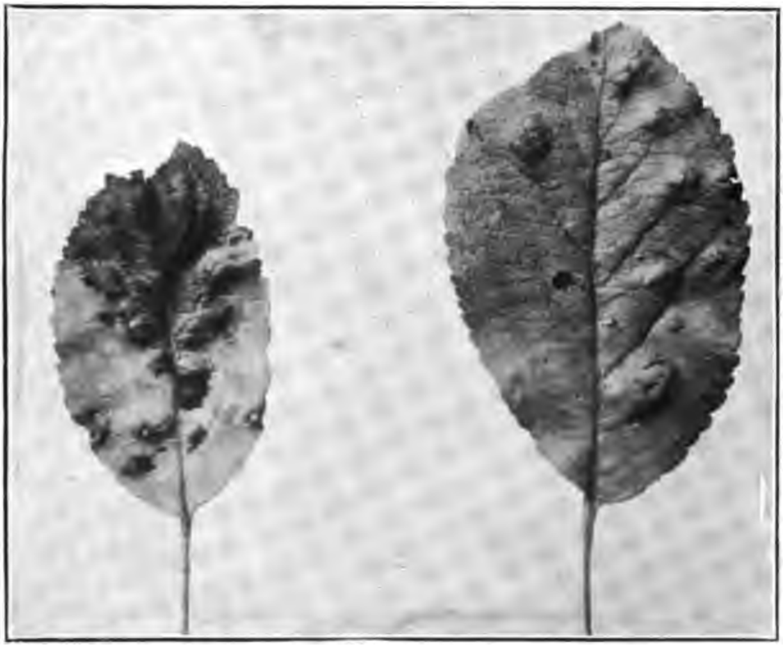
The disease more often attacks neglected trees than those in healthy condition, though this does not always hold true, as cankers have been found on apparently thrifty trees. These cankers, like very many others, originate in wounds. Care should be taken when working around the trees to injure the tree as little as possible, and when wounds are found they should be painted over or covered with grafting wax.

Treatment.—Diseased limbs should be removed wherever it is practical, or the bark should be removed and the exposed wood painted over. All diseased material should be taken from the orchard and burned. The sprayings recommended for Apple Scab will control the Canker and the Leaf Spot, but a satisfactory control for the fruit rot has not been found. However, the checking of the other two phases of the disease lessens the source of infection and, consequently, the amount of loss from the rot.

APPLE SCAB.

(*Venturia pomi.*)

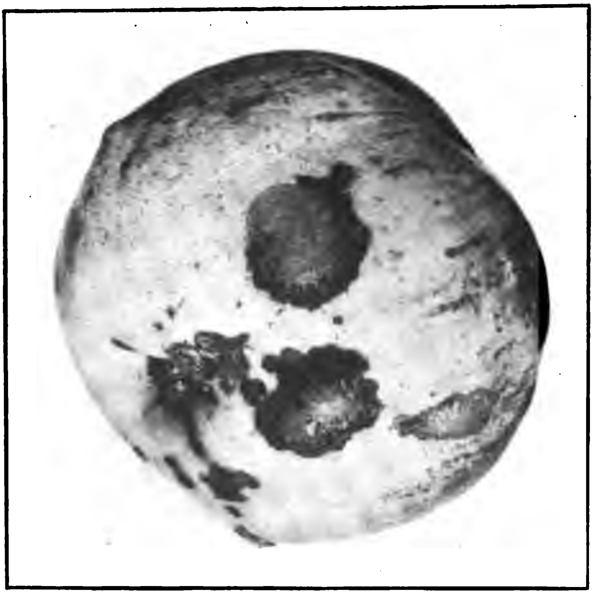
This is a widespread and destructive disease of the apple and one of the first to appear in the spring. Over most of Indiana it may be said to be one of the worst enemies of the apple grower. It begins its ravages as early as the last day of April or the first of May and continues its destruction throughout the summer and even injures the apples after they are in storage. The fungus attacks the leaves while they are young and tender and the fruit as soon as it is formed. Cold, damp weather favors the development of the fungus, and when such weather comes at the end of the unfolding of the leaves the losses from scab are particularly heavy. Another attack from Scab may come late in the fall, but this is never as severe as the spring attack.



APPLE SCAB ON LEAVES

This fungus lives principally upon leaves and fruit, but may also be found upon twigs. The fruit damage is the most important from an economic standpoint, but the leaf spot causes an early defoliation and a consequent weakening of the tree. It is in the leaves also that the fungus passes the winter. The leaf spots begin to make their appearance before the fruit has formed. At first the spots are simply slightly raised places of a lighter green color. They appear upon both the upper and the under sides of the leaves. They are about one-fourth of an inch in diameter and more or less circular in outline. Later the surface of the spot becomes velvety, as though covered with an olive-green powder. This when magnified is found to be a mass of summer spores borne on short stalks. These are the spores that attack the fruit as soon as it is formed. The spots increase in size and lose their circular outline, becoming olive-green blotches and lines. These spots continue to appear all summer, and soon the leaves become distorted and discolored and fall early in the year. During the past summer many trees were seen almost entirely bare early in August. The pustules containing winter spores develop on the fallen leaves, and these spores are discharged the following spring, just as the leaves are unfolding, and thus become the source of the first infection.

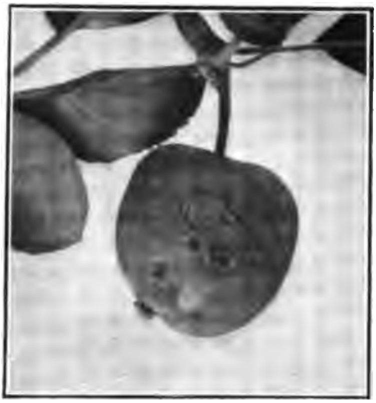
It is hardly necessary to describe the fruit spot, as it is of such common occurrence in orchards. The fruit shows greyish-green crusty or scabby patches over the surface of the fruit. The surface tissue just beneath the spot is corky, and the apple if seriously attacked is misshapen and often cracked. The scab damage in itself is superficial, but the minute cracks that appear around the edges of the spots allow the entrance of rot-producing fungi and serious rotting in storage is the result. The spores are borne over the surface of the scab spots, just as they



Apple Scab in the Autumn.

were on the leaf spots. The spores are borne throughout the summer and continue the infection upon fruit all through the season, and if any apples having the Scab are among the barreled apples infection continues in storage. Cold checks the progress of the disease, however, and the spores do not form as readily.

Treatment.—As this disease makes its appearance early in the season the means of controlling it effectively is to begin spraying correspondingly early. The first application should be made soon after the leaves unfold. This should be followed by another application soon after the petals fall. Make a third application two weeks later. This will check the spring attack. If the season favors a second attack late in the summer, another application should be made in August. For this work either Bordeaux or dilute lime and sulphur are recommended. In localities where Bitter Rot is also a serious disease the two can be controlled at the same time. (See treatment for Bitter Rot.)



Apple Scab in June on Young Fruit.

In many orchards the Scab is very largely controlled by the first spraying for the Codling Moth, just after the bloom falls.

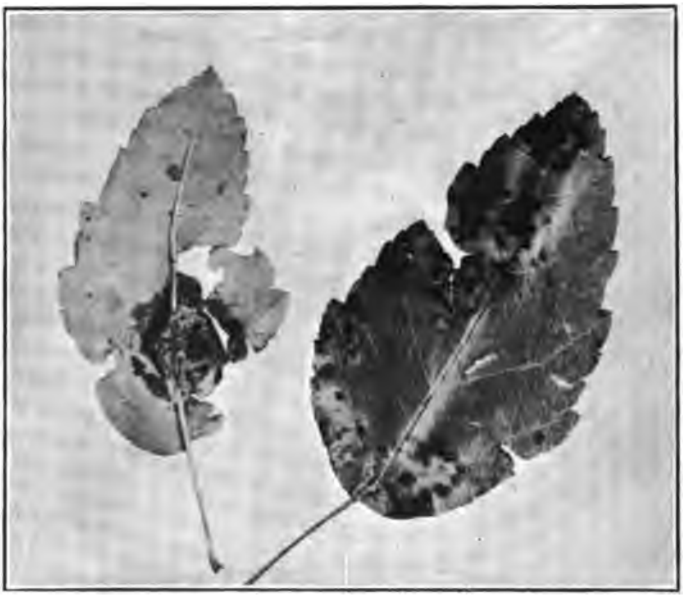
APPLE RUST AND CEDAR APPLE.

(*Gymnosporangium macropus.*)

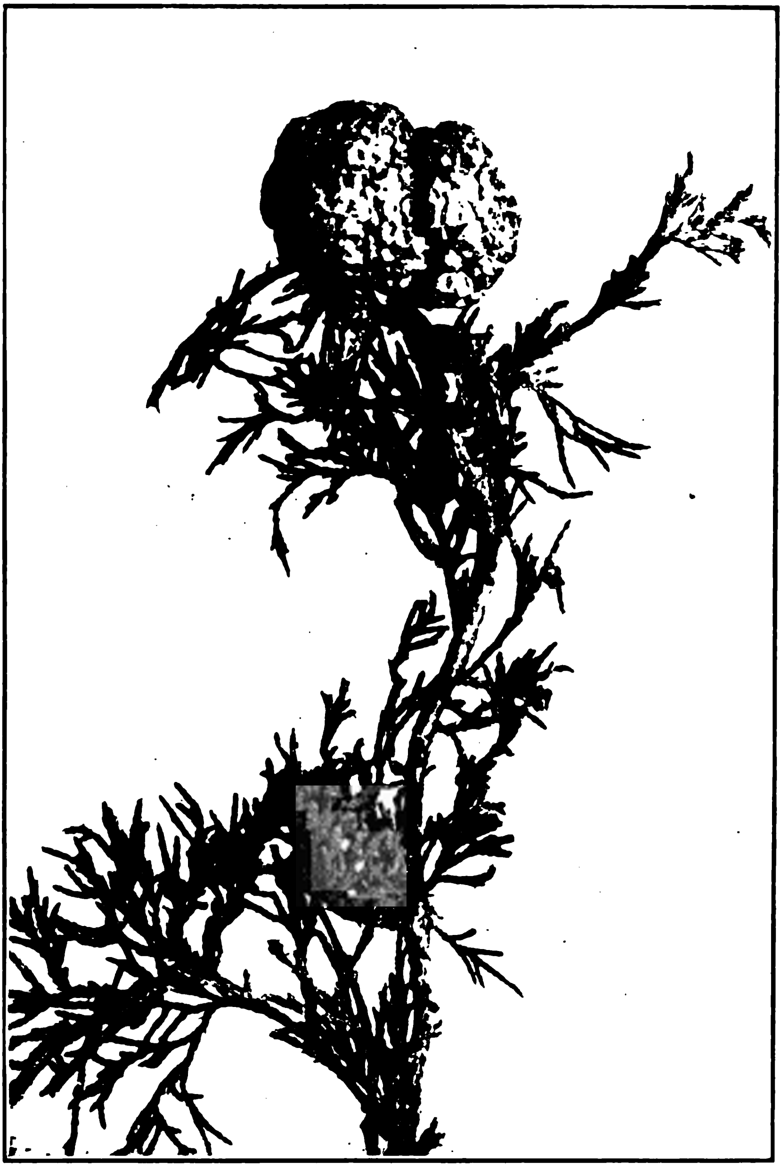
This is probably the most destructive leaf disease of the apple in districts where it is prevalent. It is especially destructive in Indiana in the southern part of the State, due to the fact that the Red Cedar is a common native tree in that district.

It is primarily a leaf disease of the apple and may also attack other trees belonging to the same family. It is quite common on the Red Haw, which is a member of the apple family. Early in the spring yellow spots appear on the leaves. When the disease is severe these spots are numerous and as they enlarge they grow together, forming large yellow patches covering a greater portion of the leaf. An early loss of leaves and a consequent weakening of the tree is the result of such an attack. During the summer delicate threads grow out from the center of the spots. These are really little tubes or funnels and are filled with spores.

This is the disease as it is known to many fruit growers, but this is only half of the life of the fungus. The spores borne in these little funnels cannot develop unless they alight on red cedar twigs. Spores which happen to fall on red cedar trees make their way into the twigs and cause gall-like swellings, which are known as "cedar apples." These develop during the winter and in the spring, usually in April. spore-bearing bodies of the fungus break out all over the surface of the cedar apples. These are fleshy, horn-like projections and become covered with orange-colored spores. These are very noticeable on cedar trees after a warm spring rain. The spores borne on cedar galls must be carried back to the apple leaves, where they cause the Leaf Spot.



APPLE RUST ON LEAVES.



CEDAR APPLE.

The Spores from this fungus growth cause the rust on Apple Leaves.

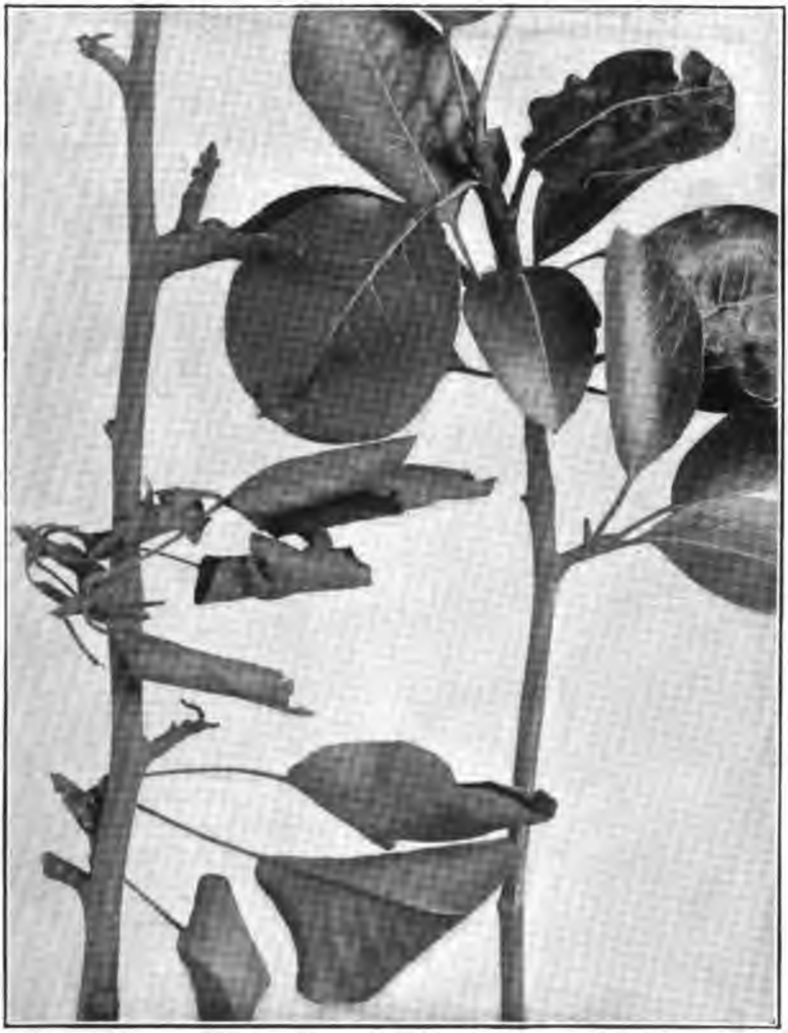
A Typical Landscape in Southern Indiana, showing Cedars. In this region Apple Rust is a serious disease.

It is plain from the above life history of the fungus that the summer is spent upon apple and the winter on cedar trees. If there are no cedar trees in the neighborhood the spores from the apple leaves can not develop and the disease can not live over the winter. The most effective treatment for the disease is to rid a neighborhood of cedars in regions where the disease is severe. I have noted cases where the orchardists have unwittingly invited the disease into the neighborhood. In one instance I noted a young orchard which had received the best of care, bordered by young cedar trees, which had evidently been planted at the same time. There are cases where the removal of cedar trees is not within the power of an individual orchardist, and in these cases spraying must be resorted to to control the apple rust. The cedar apples should be watched carefully in the spring and when they begin to put out the spore-bearing outgrowths the apple trees should be sprayed with Bordeaux or lime and sulphur. This will kill the spores as they fall on the trees. The time for this spraying is usually about the middle of April, and it should be followed by another application a month later. No definite dates can be followed, however, as the time of the development of the spores on the cedar varies with the season, and as these spores are the source of infection on the apple the time to spray is when these spores mature.

FIRE BLIGHT OF APPLES AND PEARS.

(*Bacillus amylovorus.*)

This is a very contagious disease, chiefly affecting apples and pears, and, to a less extent, quinces and plums. It is caused by the blight bacteria gaining entrance to and working on the tissues of the tree. Young apple trees suffer much more severely from the disease than old trees. When the conditions are favorable to the de-



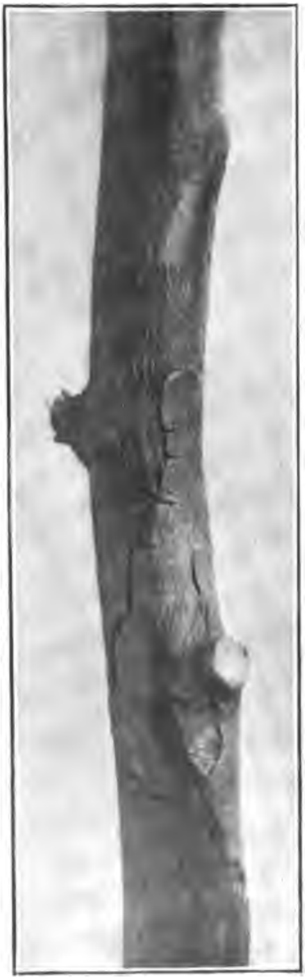
PEAR TWIGS KILLED BY FIRE BLIGHT.

The Leaves turn black, but remain clinging to the Twigs.

velopment of blight it comes in the form of an epidemic and often means the loss of an entire orchard to the owner.

The bacteria causing the blight enter through the young, tender shoots and through the flower clusters at blossoming time, and through wounds made by accident or by pruning. The first sign of the disease is a wilting of the parts attacked, quickly followed by drying and blackening. The dead leaves cling very tenaciously to the twigs and remain attached far into the winter. A tree with these blighted, blackened twigs scattered among the green looks as though it had been touched by frost. This is the disease in a mild form. When it comes in a more severe form, the bacteria, after gaining entrance, multiply rapidly, and the disease works its way down through the stem of the twig into the branch, blighting as it moves. In an incredibly short time large limbs are entirely killed, appearing as though scorched by fire.

Often the disease attacks a water sprout, and works its way from this into the trunk, and in this way gains direct entrance into the body of the tree. The trunk becomes quickly girdled, the water supply is cut off, and the entire tree stands blighted. When the water sprout comes from the base of the trunk, the girdling of the tree is commonly known as "collar rot," and by many orchardists this is considered a distinct disease and not associated with the ordinary blight. Wherever the disease has worked on the bark of the limbs or trunk, large, blackened, depressed areas of bark mark its progress. The limits of progress are marked by ridges or cracks. These areas are the "blight cankers." In moist weather a milky or gummy substance filled with the blight bacteria exudes from the cankers. Insects feed upon this substance, and when they leave, carry with them many of the germs



Fire Blight Cankers on Twigs.

clinging to their bodies. These same insects will fly to flower clusters and brush against young shoots. The bacteria which they carry are left in places where they may easily gain entrance to the tree. This accounts for the rapid spread of the disease through an orchard or even through an entire neighborhood.

The bacteria in most of the cankers die as winter comes on, but a few called "hold-over" cankers are more favorably situated, and in these the disease is able to live over the winter. In the moist weather of the following spring these cankers again exude the germ-laden liquid and from this the disease gets its start in the spring.

A TREATMENT FOR "COLLAR ROT."

It is commonly believed by most orchardists and many investigators, that well-cultivated, richly fertilized orchards favor the development of the disease in its most severe form and when blight appears in the form of epidemics in such orchards less cultivation and fertilization is advised. The treatment of affected orchards is removal and burning of diseased parts in the fall and winter. In the case of limbs that are entirely blighted care should be taken to cut the limb below the limits of the canker, to be sure that all diseased tissue has been removed. The cut surface should be painted over with corrosive sublimate to prevent the entrance of bacteria or fungus spores. The solution should be made one part corrosive sublimate to one thousand parts water. When tablets are used one tablet to a quart of water is recommended. An easy way to apply the poison is to attach a sponge soaked in the poison to the pruning shears and wash over the cut surface with this. When the trunk or the large limbs are cankered the dead bark may be peeled off and the exposed wood disinfected with corrosive sublimate. As the disease is entirely within, the tree spraying is, of course, of no assistance.

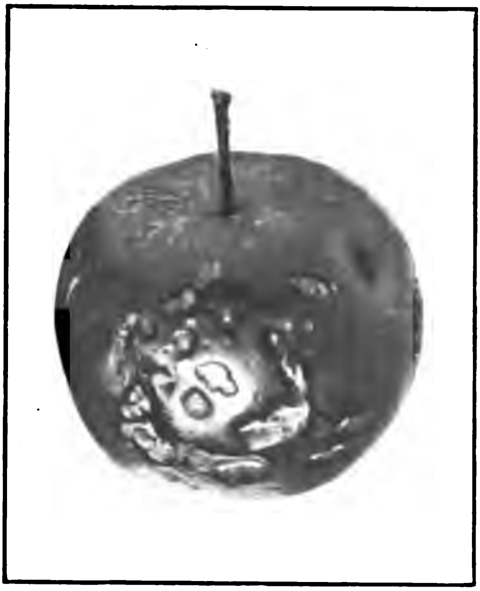
In one orchard in the State collar rot was controlled by stripping off the diseased bark at the base of the tree, washing the bared place thoroughly with corrosive sublimate and piling dirt around the trunk. When the wound healed the dirt was removed. The accompanying photograph was taken in the orchard mentioned and illustrates the means of treatment.

BALDWIN FRUIT SPOT.

(*Cylindrosporium Pomi.*)

This is a common disease of Baldwin apples, but many New England varieties are susceptible, especially the Rhode Island Greening, Northern Spy, and Talman Sweet.

At first, sunken spots of a dark color appear over the fruit. On a red apple they are a deeper shade of red, and on a green surface they appear as darker green spots. Usually they are more numerous near the blossom end. The spots when mature are about one-eighth of an inch in diameter. As they become older they become quite deeply sunken and turn brown. At this time they might be mistaken for the first stage of one of the rots. The spot does not extend deeply



Baldwin Fruit Spot.

into the apple, however, and does not increase in size. On cutting open the fruit very often small areas of brown tissue may be found scattered through the pulp of the apple. The disease does not appear on young fruit, as the fungus gains entrance through microscopic breaks in the skin caused by the rapid growth of the fruit. A few spots are sometimes found in August. When damp weather comes just before harvest time the spots may be expected to appear upon the tree, but usually there are no signs of the disease at picking time, and the spots develop after the fruit has been in storage for some time.

The injury to the quality of the apples from fruit spot in itself is not serious, as the spot is superficial. The only damage is to the appearance, as the spots often mar the fruit to such an extent that it is less marketable. The real damage from the Fruit Spot is the opportunity it gives for the entrance of fungi, causing soft rot. The spores of these fungi gain entrance to the fruit around the margins of the fruit spots and develop very rapidly. Soon the fruit spots may be recognized as dry, depressed islands, in the soft, rotted area. The pink rot fungus is often found causing this secondary rot. Very often a ring of pink spores may be found marking the border of the Fruit Spot before other evidences of the work of the fungus can be seen.

Spores of the Fruit Spot do not develop in the fall, but probably mature some time during late winter or spring on the apples that have lain on the ground all winter. From these spores the disease gets its start in the spring.

This is not a difficult disease to control. First of all, any diseased apples found on the ground should be removed. Usually one or two sprayings made late in July will effectually control the disease. Lime-sulphur or Bordeaux are recommended as sprays.

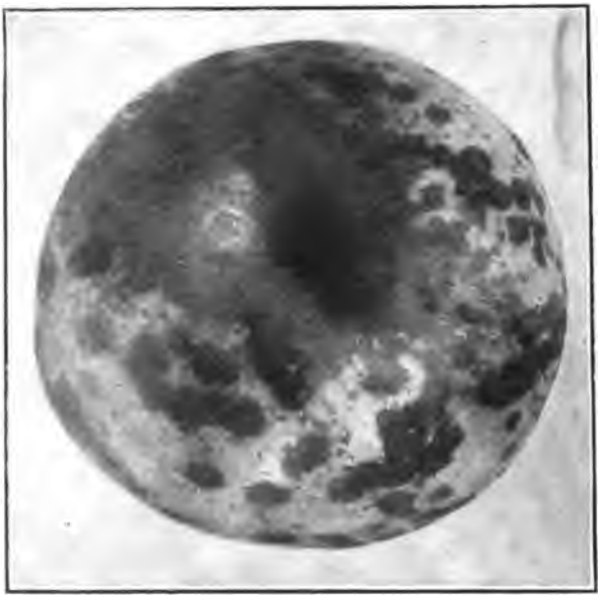
SOOTY BLOTCH AND FLY SPECK.

(*Leptothyrium Pomi.*)

These two blemishes, hardly to be called diseases, are caused by fungi living upon the surface of the fruit. They are probably caused by the same fungus, and at any rate may be considered together, as they are found in the same situations and respond to the same treatment. The quality of the fruit is not impaired by the presence of the fungus growth, but the appearance is marred, and in severe cases is made less salable.

The names Sooty Blotch and Fly Speck very adequately describe the effects of the fungus on the fruit. In the case of Sooty Blotch, the fungus grows over the surface, forming irregular gray, discolored areas, looking very much as though it had been smeared with soot. The Fly Speck refers to the clusters of black, shiny dots so commonly appearing with the Sooty Blotch, but which are not so unsightly.

Damp, shady situations seem to favor the development of this fungus and thorough pruning, allowing access of light and air to the growing fruit, will do much to prevent its appearance. Usually the fungus is kept in control by the treatment for other more serious diseases.



SOOTY BLOTCH ON APPLE.

POWDERY MILDEW.

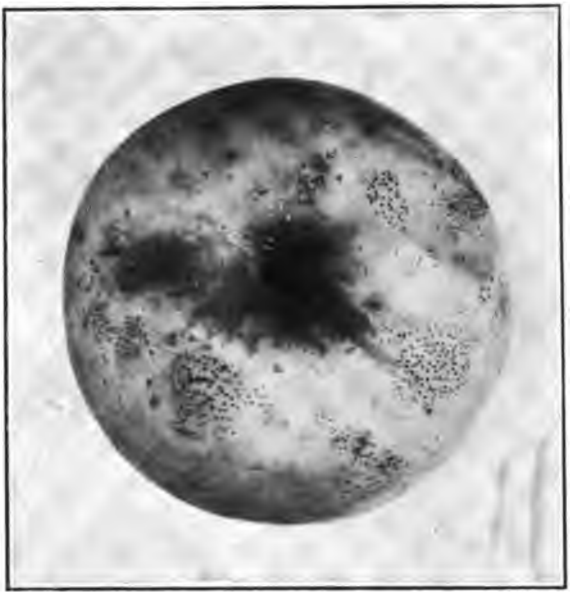
(*Podosphaera sp.*)

In moist seasons young apple and cherry trees become quite badly infested with the mildew. The fungus appears as a white powder covering one or both surfaces of the leaves, and in bad cases the entire twigs are covered with a dense coating. This disease may be quite serious when it gets a foothold in nursery rows in damp seasons. As a rule it is easily controlled by spraying with Bordeaux mixture as soon as it makes its first appearance.

CROWN GALL.

(*Pseudomonas tumefaciens.*)

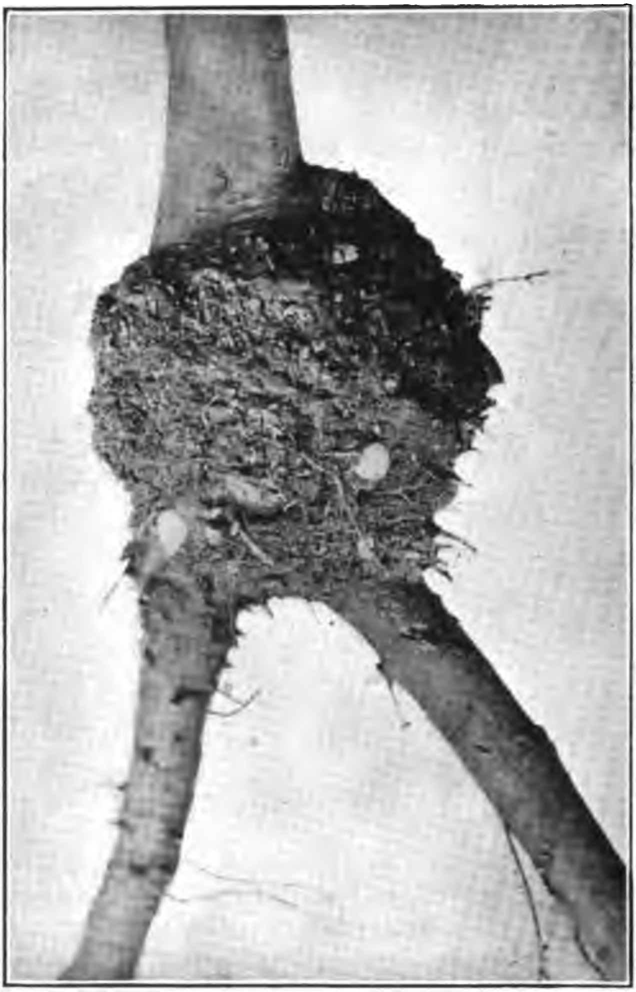
This is a disease primarily of nursery stock, and one with which every orchardist should be familiar when buying young trees. For a long time the cause of the disease was unknown, but it has now been proven to be due to the attack of bacteria. The result of the attack is the appearance of gall-like growths on the roots just at the crown. Usually this growth is two inches or less in diameter. Sometimes galls appear on the smaller roots and even on the stem, but this is not common. There are two types of gall, the hard and the soft form. The hard form is usually found on grafted trees where the scion joins the stem, or it may appear at any point where the stem or the root has been injured. This form has not been found to be contagious. The soft form is chiefly found on seedlings. These galls are at first small, white masses of soft tissue. As they grow older they turn brown and become rough and warty. They are annual growths and during the winter they rot and fall off. The following spring new galls may form on the surrounding healthy tissue. The disease does not cause the immediate death of a tree, but in time the conductive sys-



FLY-SPECK FUNGUS ON APPLE.

tem becomes impaired and results in a gradual choking off of the water supply to the parts above and sooner or later the tree will die as a result.

It is difficult to detect Crown Gall in inspecting nursery stock. as the trouble is almost entirely below the ground. As the disease attacks very young stock, it can be recognized when it is transplanted. At this time all infested trees should be discarded and destroyed. No reliable nurseryman will offer diseased stock for



CROWN GALL ON ROOTS OF NURSERY STOCK.

sale and the orchardist should examine stock carefully and see that trees are free from the disease.

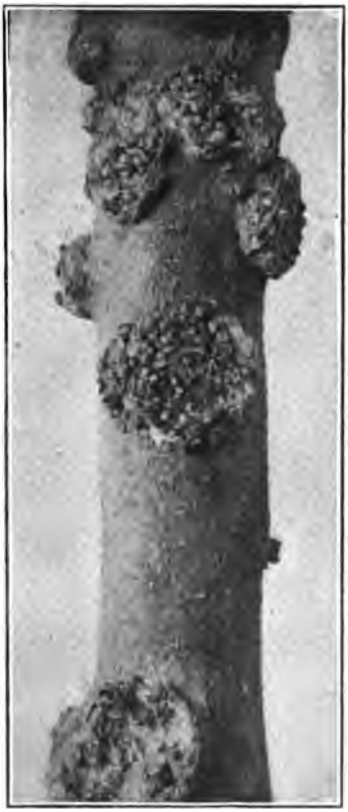
No effective treatment can be recommended. Removal of the galls has been tried and the application of fungicides, but the results were unsuccessful. The destruction of diseased trees seems to be the only thing that can be done.

HAIRY ROOT OF APPLE.

Hairy Root and Crown Gall are often found associated on nursery stock, and for a long time it was thought that there was some connection between the two diseases. They have now been found to be quite distinct.

There are two types of the Hairy Root disease. One forms on the roots and another on parts above the ground. The root form is by far the more common type. Clusters of fibrous roots develop along the tap root, and the whole root system appears stunted. When the disease attacks parts above the ground tumor-like growths develop along the trunk and limbs and even on the small twigs. The first appearance of the tumor is a smooth swelling, varying from the size of a pea to three inches in diameter. For the first few years the tumor remains smooth, but later the bark becomes ruptured and a mass of wart-like elevations is exposed. When stems bearing these tumors are buried in moist earth, clusters of roots will develop from the tumor, and from no other place along the stem. In this condition it appears strikingly like the form found on roots.

So far the disease has not been found to be contagious, but infested trees should be destroyed—never planted.



Hairy Rot as it Appears on Parts Above Ground.

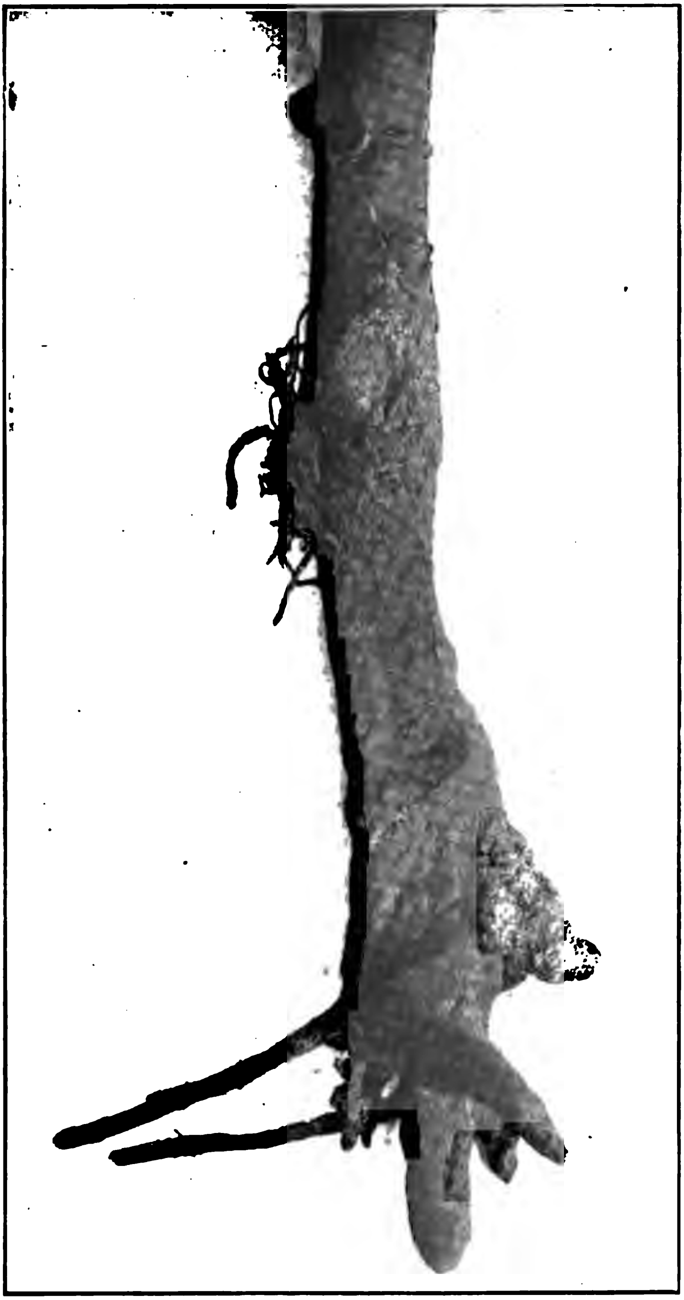
ROOT ROOT.

(*Armillaria mellia. Clytocybe connexa.*)

This is not an uncommon disease of mature apple trees, but it is not limited to them, as it also attacks peaches and plums, and a very similar, if not the same disease, is commonly found among our native forest trees.

The trouble is due to "toadstool fungi" of various sorts attacking the roots of the tree, causing them to decay. They finally become so badly rotted that the tree is easily blown over by the wind. Just which fungus causes the trouble is not definitely known, but as one or the other, or both of the forms named above are present in all cases of root rot, it may be supposed that either one may be responsible. Toadstools usually live upon dead matter, but these

FALLEN TREE—THE RESULT OF ROOT ROT.



APPLE ROOT SHOWING THE EFFECT OF ROOT ROT.

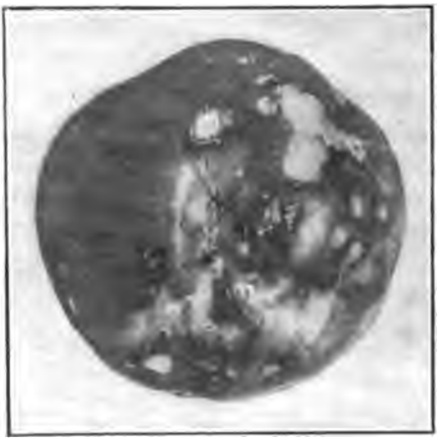
forms seem to be able to attack the living roots. If the rotted wood is examined the glistening, gray threads of the fungus body may be seen working through wood, and the soil for some distance around the decayed roots is filled with the fungus threads. The spore-bearing bodies, or toadstools, form in dense masses around the crown and bear the spores on their gills.

An orchard planted on recently cleared soil seems more susceptible to the disease. Proper cultivation will do much to make the trees more resistant. As the fungus is present in the soil where there has been a diseased tree a new apple tree should not be planted in the same place. As the disease is under ground spraying is, of course, of no use.

PINK ROT ON FRUIT.

(*Cephalothecium roseum.*)

Until comparatively recently this fungus was considered of no economic importance, but it has now been found to be quite destructive, especially in storage as secondary rot. The spores of this fungus do not seem to be able to enter into the unbroken skin of the fruit, but must have an entrance point made for them. They very often gain entrance through very minute cracks around spots on scabby apples, or around the edge of the Baldwin Fruit Spot. Neither of these diseases, Scab or Fruit Spot, cause very deep-seated rot, but when the Pink Rot fungus gets a foothold rings of brown rotted tissue appear around the spots. Very soon a ring of white mould covers the rotted area and later, when the spores form, this changes to pink. The rotted areas increase in size and run together forming large patches, often covering a considerable portion of the apple. This fungus is particularly bad in damp seasons.



Pink Rot on Apple Scab. Pink masses of Spores cover the scab spots.

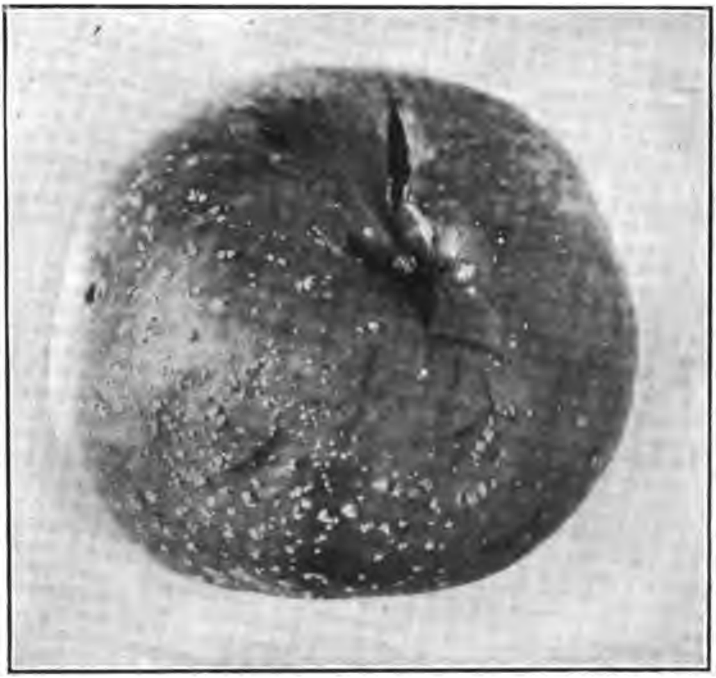
As some other disease must precede the appearance of Pink Rot the treatment of this other disease controls the Pink Rot fungus.

BROWN ROT.

(*Sclerotinia fructigena.*)

Brown Rot is a disease of apples and stone fruits, but it is far more serious when stone fruits are attacked, very heavy losses resulting from Brown Rot in peach orchards in damp seasons.

It is a disease of ripe fruit and is characterized by its brown color and the ash-gray heaps of spores scattered over the rotted surface. On apples it might easily be confused with early stages of Black Rot, but these spore masses will always serve to separate the two. The spore bearing bodies in the case of Black Rot appear as small, yet quite conspicuous, black pimples, dotted over the diseased surface. As Black Rot becomes older it becomes darker in color, while Brown Rot remains lighter in color and is a softer rot.



BROWN ROT ON APPLE.

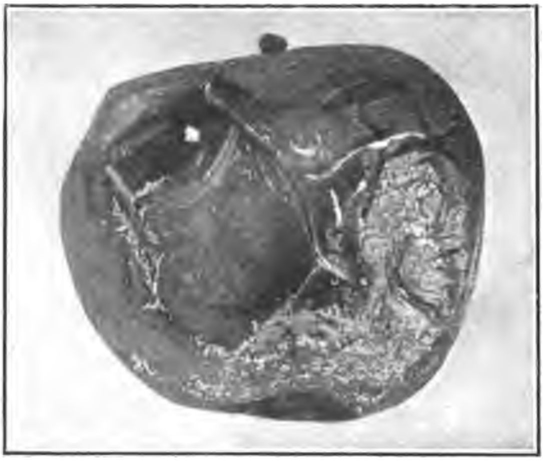
Showing ash-gray masses of Spores scattered over the rotted area.

Damp weather coming at ripening time favors the development of the disease. While it seldom attacks apples on a tree a few summer varieties, like the Chenango, are attacked at ripening time by the fungus. It is a common rot of apples on the ground and gains a foothold through breaks in the skin caused by insect stings, worm-holes or bruises. It is also a common storage rot. After the fruit has rotted it shrivels and dries and the brownish spore masses over the mummied fruit appear as a thick coating of dust. The spores remain over the winter in this condition and are largely responsible for the appearance of the disease the following season. For this reason they should be removed from the orchard in the fall. There are no special recommendations for spraying, as the spring sprayings for other diseases will satisfactorily control this one.

SOFT ROT.

(*Penicillium glaucum.*)

This is a common rot of stored apples. It is a soft, wet rot, very light yellow in color, changing to a light brown. Fungus causing the rot is the common blue mould that develops on preserved fruit. The same blue-green powder appears over the surface of the ripe fruit as is found on the preserves. The spores are distributed in the air in great numbers and develop rapidly into a mould whenever they alight where there is plenty of moisture, heat, and something from which they can absorb food. They are especially common where there is any decayed matter. The storage rooms should be kept cool and dry and free from decaying fruit and vegetables. Breaks and bruises allow points of entrance for the fungus spores and care should always be taken in the handling and barreling of the fruit.



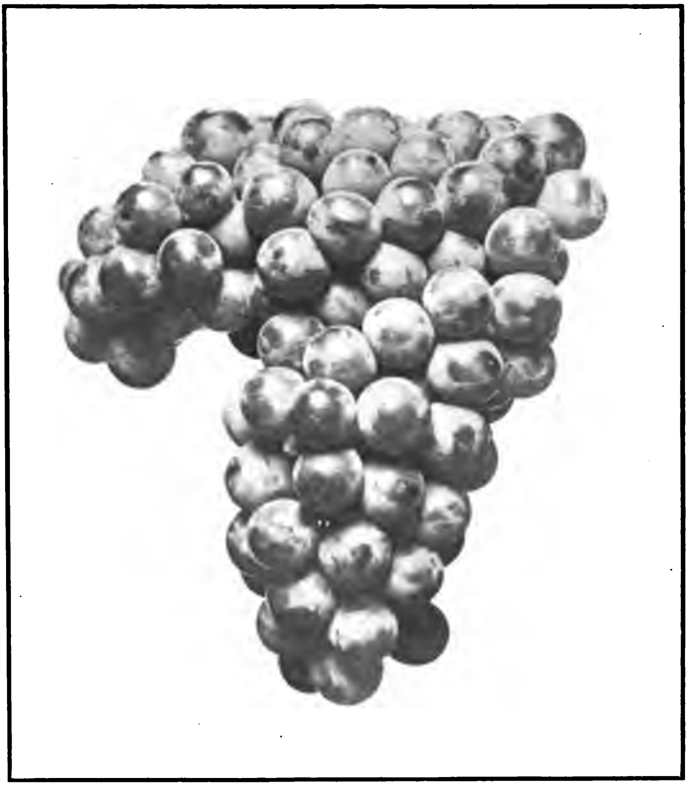
Soft Rot on Apple. Light blue masses of Spores appearing along cracks.

RUSSETTING AND BELTING OF FRUIT.

This refers to the rough, sometimes quite scaly brown areas often found on apples and pears. Sometimes this brown area is in the form of irregular patches and sometimes in very definite belts around the fruit. It is not a fungus disease, but as it might easily be taken for one, it is described here. It may be due to one of several causes. Spraying with Bordeaux mixture in damp weather will produce this effect, or it may be caused by rain or dew freezing on the young tender fruit. When the damage comes while the fruit is very young it often causes it to be quite deformed. The quality of the fruit is in no way injured, but in severe cases the appearance may be marred. No remedy can, of course, be given when the injury is the result of frost, but the Bordeaux damage can be avoided by spraying in clear weather whenever possible, or by using lime and sulphur as a substitute for Bordeaux. This is discussed under another heading in this report.

GRAPE GROWING IN INDIANA.

It is probable that the first fruit brought into cultivation by man was the grape, as there are many references to this fact in early literature. It is probable, too, that the Assyrians were the first people to undertake the culture of the grape as a regular agricultural pursuit and from their time the growing of grapes and the making of wine has gradually spread throughout the entire civilized world.



A PERFECT CLUSTER OF GRAPES.

In America the grape as a native fruit was of considerable importance even before the white men undertook to improve the varieties found in the woods. Doubtless the Indians had made considerable use of the better varieties of American grapes as they grew in their native haunts.

When the Norsemen came to America they found quantities of productive vines growing along the New England coast, and this led them to name the country "Vineland." Later, when the Pilgrims came to the district, they doubtless found similar vines and were much impressed with the productiveness of them and the excellent quality of the grape. This grape was, of course, our native northern Fox grape (*Vitis labrusca*). It has since been under cultivation and has yielded many of our most valuable varieties of grapes. In fact, most of the successful varieties of grapes for northern States have been developed from this one wild sort.

Fox Grapes (Native).

The first settlers in Indiana found our woodlands full of native varieties, not all of which, however, were palatable or of very much use to the early comers.

The Fox grape was native to Indiana, though not nearly so plentiful as the summer grape (Vitis riparia), or the Frost grape (Vitis cordifolia). These two grapes are the commonest wild grapes growing in our woods today and form by far the largest proportion of the native vines.

The Fox grape is not an unpalatable fruit, almost as large as the Concord, of coppery color, and is exceedingly hardy. It is not a fruit to be despised by anyone, at any time. The other two varieties mentioned are about the size of peas, are exceedingly sour, though it is possible to make an excellent wine from them, and they also make splendid stock for grape jelly, the latter product being excellent to serve with meat.

The first attempt at grape culture in Indiana was doubtless made by a colony of Swiss who settled in Switzerland County, in the hills bordering the Ohio River. At this place an attempt was made to grow the European varieties of grapes from which the Swiss and the French wine was made. This attempt at culture of the European varieties of grapes failed, as has every similar attempt which has been made since then. At that time it was not known just why the vines would not succeed in our country. Similar attempts have been made throughout the State many times since then. Not until 1870 was the discovery finally made that the failure of the European vines in America was due to a native American insect—the grape Phylloxera. This insect attacked the root of the European varieties, which are more tender than the American sorts, and after a season or two of sickly growth the vines inevitably died. This was the history of every planting of European grapes that was ever made in America.

WILD FROST GRAPES (NATIVE).

At about this time, too (1870), the Phylloxera had found its way to France and was rapidly destroying the French vineyards. Since then it has ruined hundreds of thousands of acres of the richest wine lands of France. Our native varieties, namely the Vitis cordifolia and Vitis riparia, are what we term Phylloxera resistent—that is the Phylloxera does not seem to attack them to any serious extent. It is on these native sorts that we have built up American grape culture as it is today. Even the tender European sorts that are grown successfully in the West and South are grafted on our own hardy native roots. This practice of grafting the tender sorts on the native American roots made it possible to rejuvenate the ruined vineyards of France. So it will be seen that while the Phylloxera of America was responsible for the vast ruin in French vineyards, America, at the same time, was the means of restoring the French vineyards by furnishing the hardy roots on which the vines could successfully grow. Today, throughout Indiana, we find that grape growing is a comparatively insignificant

WILD SUMMER GRAPES (NATIVE).

branch of agriculture, being extensively practiced in very few sections and by very few people, though most farm houses have vines for their own use. The few places, however, where any attention is being given to the grape indicate that great success should follow this work if diligent attention is given.

One of my deputies, Mr. Everett Smith, of Muncie, has for twenty years been giving grape culture attention in a small way and I am indebted to him for many facts concerning the best varieties in his part of Indiana.

In his small garden Mr. Smith has grown many excellent sorts that are practically unknown to the average consumer today.

SMALL HOME VINEYARD.

If the average person is asked what grape he considers the best he will nine times out of ten reply "the Concord." This is really one of the most ordinary sorts that can be grown in our section, ranking among connoisseurs about as the Ben Davis ranks in the apple family.

The growing of grapes for wine is practiced to a very limited extent in this State. In a few places considerable vineyards have been planted and wherever they have been well attended great success has followed. This is notably true of the Haas vineyard at Terre Haute, where some of the very finest wine is produced and where many excellent varieties are grown to perfection. Later on I desire to make more extensive mention of some of the varieties that have been successful in Mr. Haas's vineyard. Throughout southern Indiana there are many localities that are admirably adapted to grape growing and many hillsides could be more profitably planted in grapes than in any other crop.

An evidence of this is to be found in the excellent vineyard at St. Meinrad's Abbey, where several acres of hillsides are under cultivation—the grapes being used for the production of wine. The oldest part of this vineyard is now over thirty years old and is gradually being renewed, although the old vines are still in a good state of preservation and are yielding excellent crops.

VIEW OF THE VINEYARD AT ST. MEINRAD'S ABBEY.

The chief varieties planted are the Concord, Ives Seedling, and Norton's Virginia. The two latter are strictly wine grapes and are not grown for their value as dessert fruit. Many other varieties have been tested at this vineyard, but these varieties are the chief ones in culture at the present time. The Concord tends to rot on low ground, of which there is very little in the vineyard. On the high ground it is quite free from rot, even with the system of culture in vogue at the monastery, which involves no spraying, nor are the grapes sacked. This fact very distinctly shows the value of the steep hillsides as a location for vineyards. This vineyard has been planted in spacings of four by four feet. This distance is now regarded as too close and the next planting will not be made at such short distances. Father Celestine, who has charge of the vineyard, tells me that the wine is regarded as too acid to be considered a good commercial product. In some other sections I have heard it argued that the acidity of the Indiana wine made it more desirable than the extremely mild wine of the West.

SOILS FOR GRAPE GROWING.

In another part of this report I have discussed to a brief extent the soil requirements of the apple. What has been said regarding the apple is true to a very large extent in regard to the grape. The soil must, above everything else, be well drained. When this condition is fulfilled the next point that should be considered is the texture of the soil and in general it may be remarked that clay soils are more favorable to the grape than are most others.

Throughout southern Indiana there are many localities where grape growing could most profitably be combined with apple growing. The hillsides that are too steep to plant in apples could profitably be planted in a vineyard, and if necessary these steep hillsides could be terraced, as I have frequently seen done throughout the South. By such a combination of grapes and apples practically the entire area of any southern Indiana farm could be utilized for fruit culture, and I am satisfied that the requirements of the soil, climate, etc., are such to make a fruit farm of that character immensely profitable, to anyone who will give it his sincere attention.

It was formerly supposed that the vineyard must be heavily fertilized in order to be a success. This, however, is a mistake, as exceedingly rich soil tends to produce too strong a growth of cane and leaves at the expense of the fruit. Such wood is also much more liable to be injured in the winter from severe freezing. Wood that is grown on moderately fertile land will be more hardy and much less liable to winter injury. At the same time the fruit will be of better quality and there will doubtless be more of it. As has been stated regarding the apple, cultivation is really more necessary in the vineyard than is very fertile soil. Good cultivation will make up for any reasonable amount of deficiency which the soil may possess.

PLANNING THE VINEYARD.

In planning the vineyard there are several factors which must be taken into consideration. A vineyard that is planted with an eye to producing table grapes will, of course, be managed in a little different way from one that is planted with the intention of growing grapes for wine making. Often the vine planter will not desire to put out enough vines to constitute a proper "vineyard," but will desire merely to plant a few vines for home use. Doubtless such plantings will be vastly in the majority throughout our area and our directions regarding the planting and the training of vines will be based largely on the requirements of this latter class of planters. For a commercial planting the vineyard should be planted in such a fashion that the vines can be tended in the most economical manner possible and in such a fashion that the largest possible returns per acre will be realized.

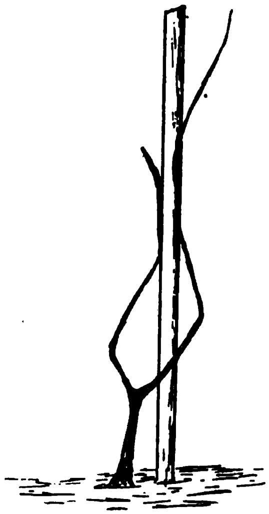
A portion of Mr. Haas's vineyard at Terre Haute that has been quite successful, is planted in rows four feet apart and the vines are set three feet apart in the rows. This is regarded as decidedly close planting and is not the spacing that should be recommended wherever extensive planting is contemplated. It will be a good plan in practically all vineyards, large or small, to space the vines eight feet apart each way. This will give an abundant amount of room for the best growing varieties and will allow enough space between the rows for a spray cart to pass and do effective work. Some varieties, like the Delaware, can, of course, be planted much closer. The vineyards should be planted on rolling land, or on hillsides if possible. There are many places in the southern part of the State where hillsides can be utilized for grape growing to great advantage. Often it is desirable in planting such hillsides to first have them terraced if they are too steep to begin with. The operation of terracing the hill slopes should be performed with a great deal of care as, if all of the top soil is removed from the hillsides, and only the gravel subsoil is allowed to remain, the vines will have nothing in which to grow.

The top soil should be saved by throwing it to one side and the bottom soil be removed, as much as may be required to form the proper terrace. The top soil should then be filled in. If the root bed for the vine is not then sufficiently deep additional soil must be supplied if the vines are going to make a successful growth. The vines are then planted well towards the back side of the ter-

A MAKE-SHIFT ARBOR.

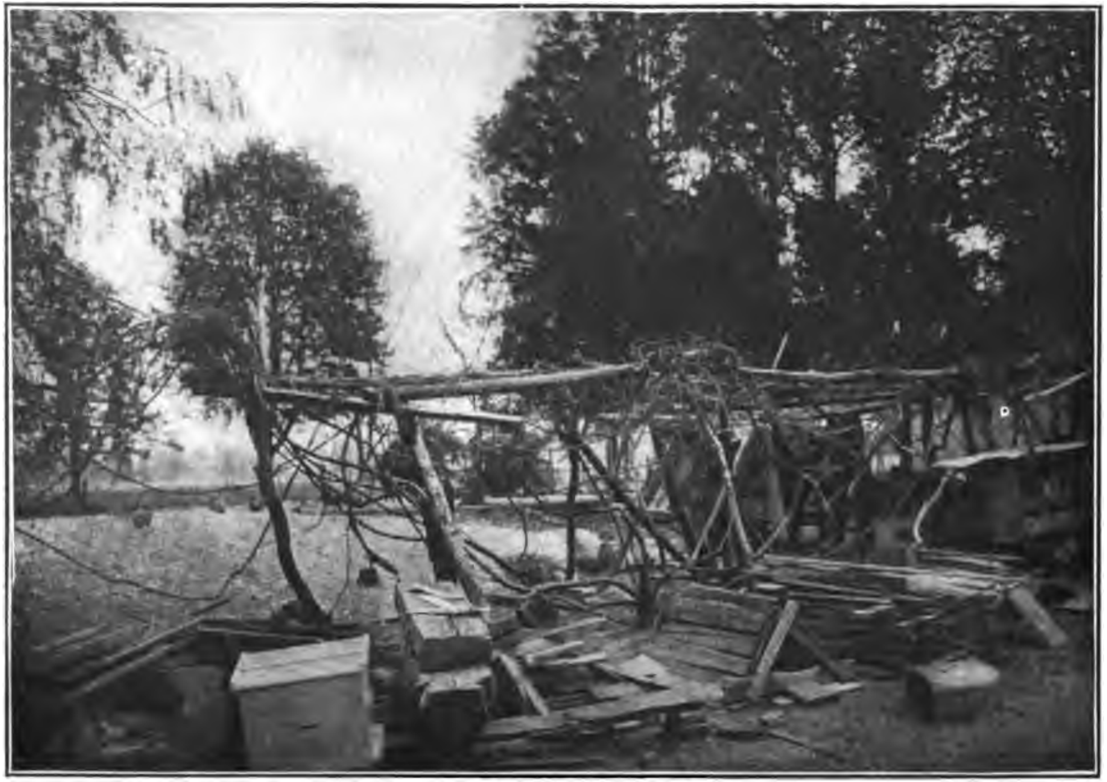
race. This gives an opportunity for a footpath along the front of the vines, so that they may be sprayed and the fruit harvested economically.

In planting quite as much care should be exercised as in planting the apple. The young vines should be one or two years old, *not more than this.* It does not seem to make very much difference in the ultimate results obtained in the vineyard, whether the vines are one or two year plants—both growing practically the same. When the vines are planted the tops should be cut back to one or two good, strong buds. In most varieties the roots should be cut back about one half. In varieties where the root growth is not vigorous the trimming back need not be quite so severe. The hole in which the vine is planted must be of such size to easily accommodate all of the roots of the vine and the vine should be planted a little deeper than it grew in the nursery. It is often an economical plan in planting grape vines to set the vines in the ground in a slanting position, with the roots spread out over the sloping side of the hole. What has been said in regard to the planting of apple trees holds good in regard to planting the grape, as far as filling in the soil is concerned. The top soil should be filled into the hole first and should be thoroughly tramped down around the roots of the vine. The subsoil should be put on top and the last soil that is filled in should be allowed to remain in a loose layer on the top of the ground. This retains the moisture while the plants are rooting and serves as the first cultivation.



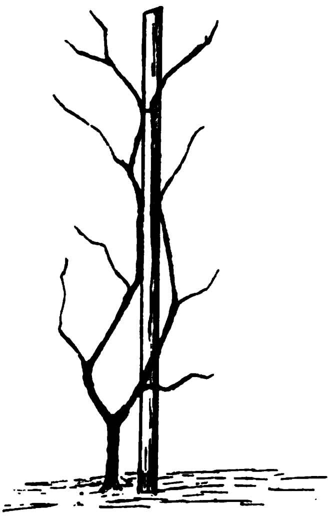
If the first season's growth has been strong the vines may be cut to two main canes, one four feet high and the other six feet high.

Grape vines may be planted either in the spring or in the fall with about equal success, though many planters prefer to set their vines in the spring of the year. Any planting made when the ground is in suitable condition—either the spring or the fall—will be equally successful. The training of the grape vine must begin with the first season of growth after planting.



A NEGLECTED GRAPE ARBOR.

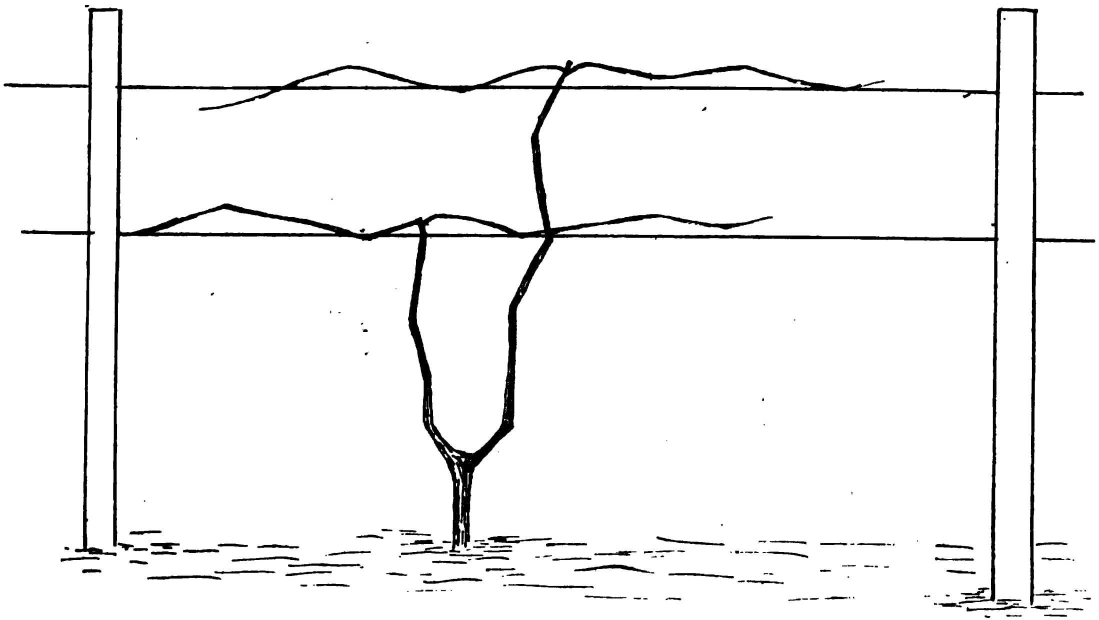
This structure supports a portion of one vine. The rest of the vine covers a large cedar tree, a few branches of which intrude at the left of the picture.



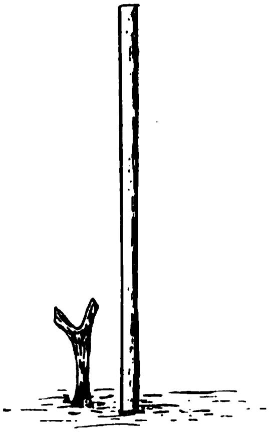
During the first year the vine may make an irregular growth. It should, however, be confined to two canes if possible

It is well to confine the first season's growth to two stalks, pinching off all lateral branches that may appear during the season. These two stalks can be tied to a stake during the summer in order to keep them up out of the way of cultivators and prevent any injury coming to them. At the end of the first season at least one of these stalks should be almost six feet high. If they have not reached this growth (and very often they will not reach it) the vines should be cut back to two strong buds. The second season these buds are allowed to grow, forming again two strong shoots, which will undoubtedly reach the required length before fall. This will be at the end of the second summer's growth.

The vines are now ready to tie to a permanent support, after which they can be allowed to throw out fruit-bearing laterals. The most effective and the most economical support for grape vines consists simply of number ten wire strung between stout posts. For the system of training described herein there should be two of these wires, one at a height of six feet, and the other at a height of four feet. The two main canes which have been grown in the first or second season, as above described, are attached to these wires, one of the canes being cut off at four feet and the other at six feet. The taller cane will produce laterals which are tied to the top wire. The shorter cane produces two other laterals which are tied to the lower wire. These lateral branches are produced the second or the third season after the vines are planted, depending on the success of the first season's growth. It is from these lateral branches that the fruit bearing shoots will spring. Accordingly the third or fourth summer after planting, the laterals which are tied to the two wires described, will throw out fruit-bearing canes. These canes, it will readily be seen, will droop from the laterals attached to the heavy wire.



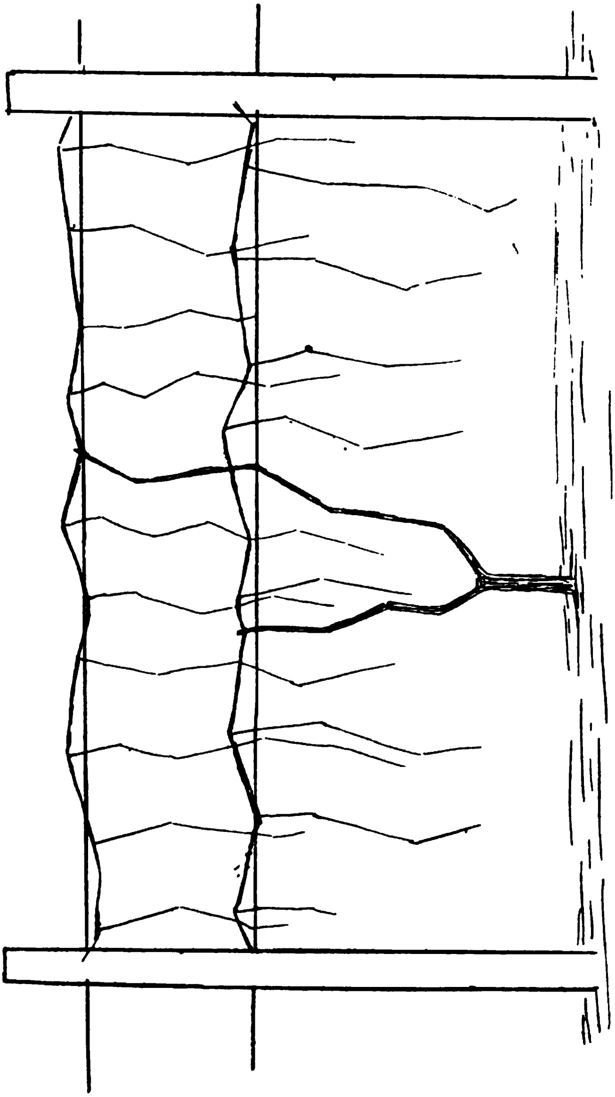
AT THE END OF THE SECOND (OR THIRD) SEASON, THE VINES SHOULD APPEAR AS ABOVE AFTER BEING TRIMMED.



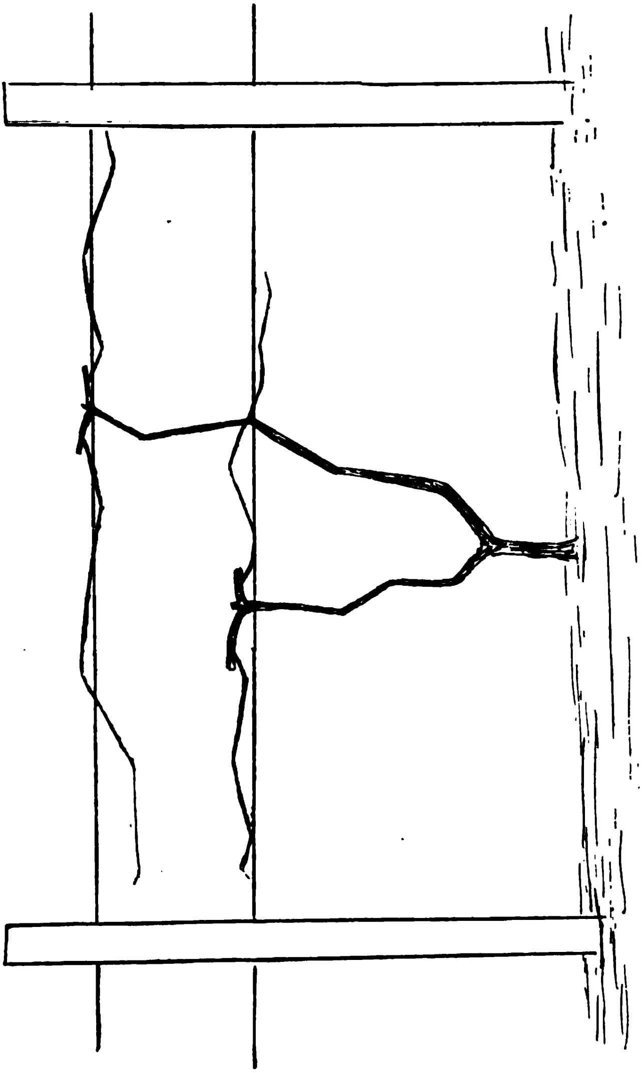
In case the first season's growth was not strong the vine should be cut back to two strong buds.

As the vines grow during the summer these drooping shoots must be carefully watched. All of the fruit that forms on the four shoots closest to the trunk of the vine must be removed, as this shoot is to play an important part in the future system of the vine. The fruit that is borne on the vine will be produced on the balance of the fruit shoots which are thrown out. At the end of the season, after this crop of fruit has been gathered, the laterals that were tied to the two wires are removed at a point close to the four branches from which the fruit has been removed early in the season, thus removing all of the wood which has borne fruit. These canes are then brought up to a level with the old laterals and after being cut back to the desired length are tied to the wires, taking the place of the laterals which have been removed. In this way the pruning of a grape vine that has been properly trained requires but few cuttings each year. All of this is more clearly illustrated in the accompanying diagrams.

The system of pruning which I have just described is a modification of what is known as the Knifin drooping system and it possesses several advantages over any other system of grape training that I have ever seen published. In the first place the trunk of the vine is long and can readily be laid down for the winter and covered with straw. In this way very tender varieties can be grown in sections that ordinarily would not produce them at all. This is an advantage, of course, that would mean more to the small grower than to the commercial vineyard. In the second place it is possible to grow other crops beneath the vines, though such crops should be confined to vegetables, such as garden crops, or peonies, roses, or some similar plant, which will not be too much of a tax on the soil of the vineyard. In the third place, by the adoption of some such system of pruning, it is possible to regulate the size of the crop by one pruning. This is done by the removal of as many fruit spurs as may be desired when the two laterals are brought up and tied to the wire. Grapes pruned in this way require only one tying each year, that is when the vines are pruned and the two laterals are brought up. The fruit canes do not require any tying



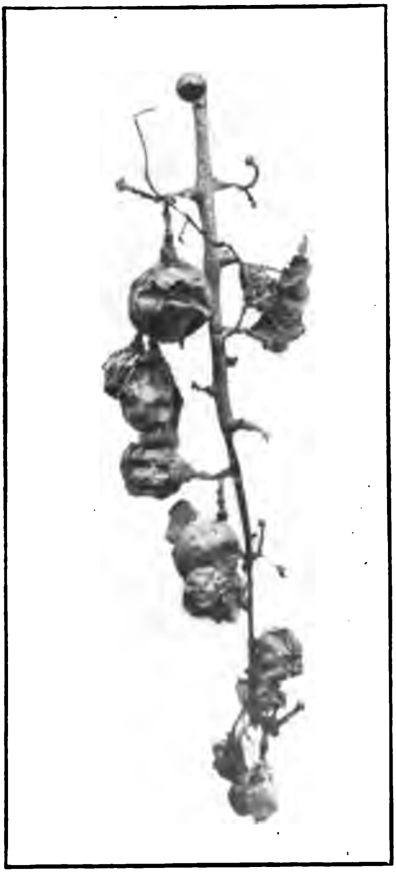
THIS SHOWS THE WAY THE VINES WILL LOOK AT THE END OF THE THIRD (OR FOURTH) SUMMER, AFTER THE FRUIT HAS BEEN GATHERED AND BEFORE THE VINES ARE TRIMMED.



APPEARANCE OF THE SAME VINES AFTER BEING PROPERLY PRUNED.

as they droop from the supporting laterals. The fruit is produced at a good height for the best results, and is at a convenient height for spraying and for gathering. The high wires make it easy to get around from one part of the vineyard to another. This is, of course, a minor point, but anyone who has had to scramble through the low, close wires of the average vineyard will appreciate this one advantage.

As I said before, in order to make such a system of pruning most effective, it must be started as soon as the vines are planted. The vines must be trained with the idea in view that they will sometime be handled on this drooping system. If the preparatory work is properly done the vineyard can be pruned with less labor than by any other system of handling. I fear, however, that many grape planters will fail to realize the necessity for watching their grapes while the vines are young. This must be done if trouble with this pruning system is to be avoided.

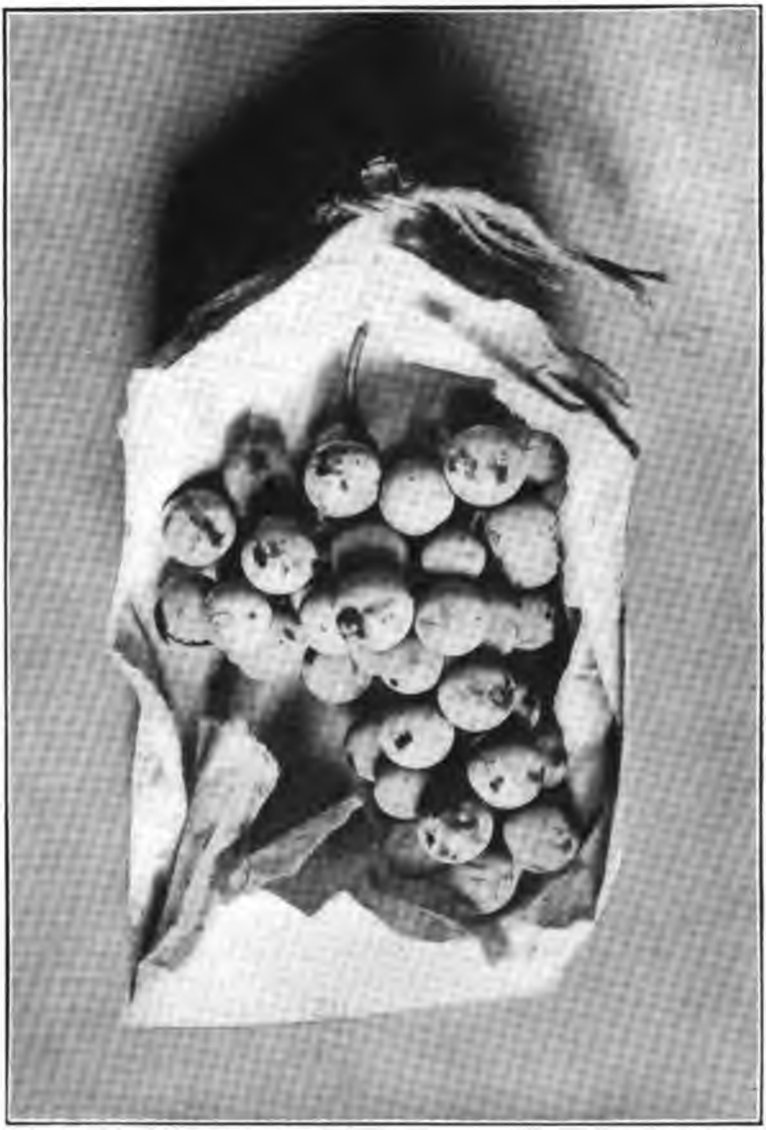


Cluster of Grapes from the same vine as shown on page 183.

SPRAYING.

In recent years grape spraying has become to be quite as necessary for the production of good fruit as is apple spraying for the production of good apples.

The Black Rot and the Grape Berry Moth have become so widely distributed that there are very few sections where they are not found to a considerable degree, and very few varieties are at all resistant to their attacks. They can be prevented to a certain extent by clean culture in the vineyard and by giving the vines the proper exposure to the sunlight and air,



PAPER BAG TORN OPEN, SHOWING A PERFECT CLUSTER OF GRAPES ON THE INSIDE.

None of these preventatives, however, are absolutely certain, and in most cases we must resort to spraying. For this purpose there is nothing better than the sprays which have been recommended for apple growing, notably the Bordeaux mixture and the Arsenate of Lead.

Practically all trouble to the fruit can be avoided by tying the bunches in paper bags as soon as the berries are formed. This work cannot be done too soon after the berries are actually set in the bunches. Of course, this could not be done before the flowers have been fertilized. Any time after that, however, is a proper time to sack grapes. The grapes are bagged in paper sacks in order to prevent the adults of the grape berry moth having access to them, and also to keep the spores of rot-producing fungi away from the fruit. The paper bag should simply be slipped over the bunch of grapes and the top of the bag gathered neatly in around the stem and then tied securely with a cotton string or pinned with a common pin. It is also a common practice to bring the bag up to the main stem and fold it over the top of the stem and then fasten it with a pin. This is, perhaps, a more secure method than the one just mentioned. The accompanying illustration speaks more eloquently than words can possibly do for the results obtained by this system of handling grapes. While the system will appeal more to the small grower of grapes who desires some fine fruit for his own use, it is not an impractical system for a commercial planting, and in some sections has been practiced with very great success. The fruit on the sacked vines is not only free from insects and fungi, but is of better quality and of finer appearance and free from the accumulation of dirt which unsacked grapes are sure to have. Sacking will, of course, be no preventative of those fungus troubles which attack the leaves. Notable among these is the grape mildew which renders the growing of many otherwise valuable varieties rather uncertain.

MARKETING THE GRAPE.

Grapes may be marketed either as a fresh fruit, as raisins, as wine, or as unfermented grape juice. The available markets in and around Indiana are so extensive that the marketing of the fresh fruit should be particularly profitable in this State. The closer to the market that the vineyard can be situated the greater will be the percentage of profit, owing to the better condition in which the fruit reaches the consumer.

Wherever they are shipped they should be packed in baskets. The growing of grapes for the making of raisins is not to be recommended for Indiana. The raisin industry of California is so extensive that to try to compete with it in this section would be a mistake.

There seems to be a wide diversity of opinion in regard to the possibilities of making wine in Indiana. Personally I have visited a number of places in Indiana where wine is being made and in most places I would not regard the wine as being of sufficiently good quality to warrant its being placed on the market. In a few other places, however, the wine that is produced is so very excellent that it should have a wide sale. The present temperance wave that is going over the country will doubtless have some influence in increasing the consumption of home-made wine, though the market for the product will doubtless be more restricted than it has in the past. In one of the best vineyards that I visited in Indiana it seems to be easier to make a good wine than to sell it. The fact that the drinking portion of our population confines itself very largely to beer and whiskey is another factor that makes the production of wine rather a doubtful venture in Indiana. Personally I am inclined to feel somewhat as does an old German winemaker that I talked to. He was in favor of placing a very high tax on the sale of beer and whiskey and a low tax on the sale of wine, the argument being that he had never seen a man drunk from drinking wine, and in thinking the matter over I do not believe I have ever seen such a case of intoxication myself.

At the present time there seems to be an enormous demand for the product known as "Unfermented Grape Juice." This demand is steadily growing and has reached such proportions today as to make the planting of vines for this purpose quite a profitable investment. This unfermented product has many devotees, and as the market for it is growing constantly I can see no reason why the growing of grapes for the production of unfermented juice should not prove to be an exceedingly profitable branch of agriculture in Indiana in the future. For this purpose the Concord grape will doubtless prove an excellent variety, as has been suggested under the discussion of that variety. The following information on the making of unfermented grape juice is taken from a government report on that subject:

"Use only clean, sound, well ripened, but no over-ripe grapes. If an ordinary cider mill is at hand it may be used for crushing and pressing, or the grapes may be crushed and pressed with the hands. If a light colored juice is desired put the crushed grapes in a cleanly washed cloth sack and tie up. Then either hang up securely and twist it or let two persons take hold, one on each side of the sack, and twist until the greater part of the juice is expressed. Then gradually heat the juice in a double boiler or a large stone jar in a pan of hot water, so that the juice does not come in direct contact with the fire, at a temperature of 180° F., never above 200° F. It is best to use a thermometer, but if there be none at hand heat the juice until it steams, but do not allow it to boil. Put it in a glass or enameled vessel to settle for twenty-four hours; carefully drain the juice from the sediment and run it through several thicknesses of clean flannel, or a conic filter made from woolen cloth or felt may be used. This filter is fixed to a hoop of iron, which can be suspended wherever necessary. After this fill into clean bottles. Do not fill entirely but leave room for the liquid to expand when again heated. Fit a thin board over the bottom of an ordinary washboiler, set the filled bottles (ordinary glass fruit jars are just as good) in it, fill in with water around the bottles to within about an inch of the tops and gradually heat until it is about to simmer. Then take the bottles out and cork or seal immediately. It is a good idea to take the further precaution of sealing the corks over with sealing wax or paraffin to prevent mould germs from entering through the corks. Should it be desired to make a red juice, heat the crushed grapes to not above 200° F., strain through a clean cloth or drip bag (no pressure should be used), set away to cool and settle, and proceed the same as with light colored juice. Many people do not even go to the trouble of letting the juice settle after they strain it but reheat and seal it up immediately, simply setting the vessels away in a cool place in an upright position where they will be undisturbed. The juice is thus allowed to settle, and when wanted for use the clear juice is simply taken off the sediment. Any person familiar with the process of canning fruit can also preserve grape juice, for the principles involved are identical.

One of the leading defects so far found in unfermented juice is that much of it is not clear, a condition which very much detracts from its otherwise attractive appearance, and due to two causes already alluded to. Either the final sterilization in bottles has been at a higher temperature than the preceding one or the juice has not been properly filtered or has not been filtered at all. In other cases the juice has been sterilized at such a high temperature that it has a disagreeable scorched taste. It should be remembered that attempts to sterilize at a temperature above 195° F. are dangerous so far as the flavor of the finished product is concerned. Another serious mistake is sometimes made by putting the juice into bottles so large that much of it becomes spoiled before it is used after the bottles are opened. Unfermented grape juice properly made and bottled will keep indefinitely if it is not exposed to the atmosphere or mould germs, but when a bottle is once opened it should, like canned goods, be used as soon as possible to keep it from spoiling."

Bulletin 24 of the Bureau of Plant Industry contains information of value to those who desire to engage in the manufacture of Unfermented Juice on a large scale.

VARIETIES OF GRAPES FOR GROWING IN INDIANA.

In attempting to outline a list of grapes suitable for planting in Indiana, I realize that I am undertaking a task that is certain to result in unfavorable criticisms, from some quarters. There is no fruit under cultivation that presents so many variations with different handling. A variety that may be highly successful under the management of some particular grower, or in some particular locality, may be an utter failure in some other locality, only a short distance removed. This fact has led to a great deal of discussion among grape growers and in some cases has resulted in more than one name being applied to the same variety of grapes. The following list includes grapes that are desirable for market purposes, for home use, and for wine making, and this list is compiled from the experience of a great many grape growers throughout the State. Varieties marked with an * are not self-fertile and should be planted near fertile varieties in order to insure pollenation.

BLACK VARIETIES.

CONCORD.

The Concord grape has been called the Ben Davis of the grape family. It is undoubtedly one of the most successful of the commercial grapes that has ever been grown in America. The vines are hardy, healthy and very productive, succeeding throughout our area. While the grape itself is not of the best quality, it is still of *fair* quality and the general public has been educated to believe that the Concord grape is all that is to be desired in this sort of fruit. Accordingly the grape has enjoyed immense popularity for many years. Doubtless it will continue to be a popular commercial grape for many years to come. When grown for home use the Concord is of better quality if it is allowed to remain on the vines until thoroughly ripe. In this condition, however, it does not keep well so that thorough ripening cannot be allowed in commercial vineyards. In the southern part of the State the Concord tends to rot, especially if planted on low ground, and must frequently be sprayed to be successful. The variety will prove more valuable north, as it is a distinctly hardy sort. At present there is an enormous demand for unfermented grape juice. This demand is increasing yearly and is being supplied very largely with juice from the Concord grape. The grapes, being such abundant bearers, are among the very best sorts to grow for making this popular article. Wine has sometimes been made from the Concord grape, but it is not of the best quality and there are varieties that are better adapted to this purpose.

WORDEN.

This grape is a seedling of the Concord and is regarded as the best of a large list of seedlings that have been put out from time to time by enthusiastic grape growers over the country. It is earlier than the Concord and of better quality. In most cases it is less liable to rot than is the Concord, making it a more desirable sort to grow. All things considered, the Worden will doubtless replace the Concord in many commercial plantings.

* HERBERT.

This is a splendid black grape, earlier and later than the Concord, but of very much finer quality and almost as vigorous and healthy. The fruit remains on the vine in good condition longer than does the Concord. It is, however, not so hardy as the Concord, and cannot be grown in so many localities as can the above-mentioned grape. The berries are borne in large clusters and are of unusual size and magnificent appearance. By many people the Herbert is regarded as the best black grape. This is an opinion which, of course, will vary with the locality in which the grapes are grown, as it does not succeed uniformly in all places. It is a grape well worth trial in the home vineyard, but I would hesitate to recommend it for large commercial plantings.

* BRIGHTON.

The berries of this grape are dark maroon, almost black in color and of medium size. This grape has a reputation for being somewhat tender, but Mr. Everett Smith has grown it successfully as far north as Muncie. It is an excellent table grape and might be planted for the home use in a small way. Shortly after it becomes fully ripe it loses much of its quality, thus becoming a poor sort for the market.

MOORE'S EARLY.

This grape might be described as a large early Concord, though it is, as a rule, not so productive as the Concord. It is distinctly valuable, however, because it is ripe about two weeks earlier than the Concord and so supplies the early market. This makes it a distincly valuable grape for commercial purposes.

BRILLIANT.

This grape is vigorous, hardy and of fine quality. The bunches of berries are large and of such a texture that they stand shipping very well. The grapes, however, are somewhat subject to disease and must be sprayed to prevent the attack of mildew. The grape is of a sufficiently good quality to be classed as a fine table grape and is a good enough shipper that it should prove a good market grape as well. It is recommended for the southern part of the State.

WILDER.

This is a grape ripening a little before the Concord. The bunches of berries are large, black in color, and resemble to a certain extent the Black Hamburg. The grape is splendid for table use, but must be sprayed if it is to produce the most perfect fruit. The fruit also keeps well after it is ripe. It is recommended for the southern part of the State.

CAMPBELL'S EARLY.

This grape is similar to the Moore's Early, but is much better in quality and keeps much better after it is gathered. It should prove a valuable market sort.

EARLY OHIO.

This is a distinctly early grape, ripening ten days before the Moore's Early. It is not of good quality, but is handsome in appearance, and its very early season ought to make it a desirable commercial grape for market purposes. It is not recommended for home planting.

RED VARIETIES.

WOODRUFF RED.

This variety might be termed the Red Concord, as it possesses the Concord hardiness and vigor to such a marked degree. The Woodruff Red is a successful grape in a large part of the State and proves a valuable market sort wherever it is grown. The bunches of berries are of good size and of excellent quality, though many connoisseurs regard them as too foxy to ever receive high rank. At Terre Haute, Harry Haas has been growing this grape successfully as a market grape and tells me that the grapes frequently bring as high as ten cents a pound on the Terre Haute market. Such a record should stamp the grape as a successful commercial sort. I would not hesitate to plant it in a commercial vineyard anywhere in Indiana.

* LINDLEY.

The bunches of berries are medium to large size. The color is described as a brick red. The grapes are a fine, good quality, tender and sweet. The vines are vigorous and healthy, but are not always productive. The variety is early and keeps well. It is regarded as an excellent table grape, but cannot be recommended for a commercial variety for the reasons mentioned. The flowers are imperfect and the variety must be planted close to some other variety in order that the fruit may be properly fertilized.

IONA.

This is a red grape of fine quality but is very tender and requires much care to grow it to perfection. It is recommended for family use only. The fruit keeps well, but the vines are liable to overbear and must be short-pruned. It is recommended for the southern part of the State. This is the most popular table grape in the Cayuga Lake region of New York.

JEFFERSON.

This is a light red grape of excellent quality, said to be equal to the Iona. The vines are vigorous and are more hardy than is the previous sort. It is one of the best table varieties, and as it keeps as well as the Iona it should be a successful market variety as well. Mr. Smith has grown the Jefferson successfully as far north as Muncie.

DELAWARE.

This grape is small in size, but is very fine in quality. It has been called by some writers the best American grape. The fruit does not rot and the vines are hardy and quite productive. They are, however, slow growers and the grape does not succeed in all localities. It requires a deep, rich soil, that must be well drained. Hillsides are preferable to level land for the growing of this grape. If the conditions for its production are all right it is one of the best market grapes we can get. It could be grown and should be grown for home use anywhere. It has also been called the best wine grape, though there are many winemakers who would dispute this statement.

DIANA.

This is a sort that is exceedingly variable in quality and has succeeded in some places only to fail miserably in other sections. It might succeed well in the southern part of the State, but I would not recommend it for other portions. It is quite late in the season.

* GOETHE.

This is a pale, red grape of splendid quality. It is tender, however, and is recommended only for the southern counties. It does best in a sandy soil and where the conditions are proper the vines are quite vigorous. It grows to perfection on the south side of buildings.

LUTIE.

This is another grape very varying in quality, though where it does succeed it is regarded as an excellent sort. It is a vigorous grower, and the fruit is fine in quality when it is good. It is not recommended for market planting, and only for home planting in the southern counties.

WHITE VARIETIES.

MOORE'S DIAMOND.

This is regarded as the best white market grape. The vines are hardy, vigorous and productive. It has been regarded as a white Concord, but is of distinctly better quality, and is compared to that variety only because most people are familiar with the Concord grape and it has thus become a standard for judging practically all sorts, good or bad. The Diamond is recommended for market growing only, as there are other sorts that are of better quality, though not so productive as the Diamond.

POCKLINGTON.

This is an excellent white grape that should prove successful, not only for home use but also be good for a market grape. It is equal to the Concord in everything but quality. In this it excels the Concord. In a few places in southern Indiana I have heard complaints that the Pocklington was not of a good quality for a table grape, but that it was a splendid grape for canning or for preserves. This statement I have not verified by any personal experience.

EMPIRE STATE.

This white variety was heralded as one of the finest grapes produced, but it has caused disappointment in many localities, being another sort that is extremely variable in different sections of the country. Where it does succeed it is said to be of excellent quality and I believe it is worthy of trial anywhere. I would recommend it particularly for the southern part of the State, though I am trying some as far north as Indianapolis.

LADY WASHINGTON.

This is a vigorous grower, healthy except for some tendency to mildew. The bunches are large—the berries medium. The grapes are of fine quality ripening after the Concord. The Lady Washington requires good care and attention if it is to produce the best results. Where it receives good care, however, it becomes one of our very finest table grapes. Mr. Smith has grown this grape to perfection at Muncie and some of his specimens are certainly all that could be desired in the way of a table grape. It is not recommended for commercial planting.

NIAGARA.

This is one of our best white market grapes that has been very extensively planted over the eastern part of the country. The vines are very strong growing and are abundant bearers. The grape should be extensively planted in southern Indiana for market purposes.

GREEN MOUNTAIN.

This is a very early white sort, of good quality, that should prove to be an excellent market grape throughout Indiana. The grapes, however, are somewhat tender in texture, making them poor shippers. It has been reported as doing unusually well in southern Indiana, where it should be more extensively planted.

WINE GRAPES.

The following varieties are distinctly wine grapes, not being grown for table purposes in any place of which I know. They are not of such quality as would make them desirable for table use or for cooking. They are adapted particularly for the making of wine and for this purpose there are few other grapes that will excel them.

CLINTON.

This is an old standard wine grape of black color growing in small, compact clusters. The berries themselves are also small, but are exceedingly free from all diseases. The vines are healthy and hardy and of an exceedingly rank growth. The Clinton makes the very best possible vine for growing over a trellis where shade is desired. It is often used for covering unsightly places or for outbuildings of any sort. The Clinton makes a wine of the Claret type that is of a fairly good quality, provided it is properly aged. Where the wine is new it is not of good quality, but is coarse and does not have a very good reputation. In the past, however, the Clinton has been extensively planted for the making of home wines, and it is an old favorite.

IVES SEEDLING.

This grape has been called the best wine grape, but there are many growers who will not agree with such a decision. The wine made from the Ives grape is not of such good quality as that made from some other varieties, but the grape is a very reliable cropper and possibly it would be a good variety to plant in many sections.

NORTON VA.

This is the most reliable of all wine grapes that can be grown in Indiana. The vines are exceedingly hardy and the fruit practically never fails. This year at St. Meinrad's Abbey there is a full crop of Norton Va. when practically all other varieties have failed in that locality. The grapes are very late in the season. I have been told by Mr. Haas, at Terre Haute, that the Norton Va. was first brought into prominence as a wine grape, shortly after the Civil War, by German army officers who had been in the war and were familiar with the best German wine. It is said that the wine from this grape resembles foreign wine very closely. The variety is rot-resistant and is usually quite a heavy bearer.

MISSOURI RIESLING.

This is a white grape of fairly good quality and an excellent bearer. It makes a good grade of wine and the fruit is not subject to rot. At Terre Haute the grape has been quite a success and could be a success over much of Indiana,

INSECTS AFFECTING THE GRAPE.

The fact that the grape vine is so widely distributed in Indiana, doubtless acounts for the fact that more than two hundred different insects have already been listed as injuring the vine in America. Comparatively few of these insects, however, are of any serious importance. In fact, as far as our Indiana conditions are concerned, we can say that there is practically only one insect to be feared by the grape grower. This is the Grape Berry Moth, which is responsible for the wormy grapes in all sections of the State. About a dozen others which injure the plant body will be taken up separately. Several of these insects may become decidedly injurious and should be diligently watched for by the vineyard owner.

GRAPE BERRY MOTH.

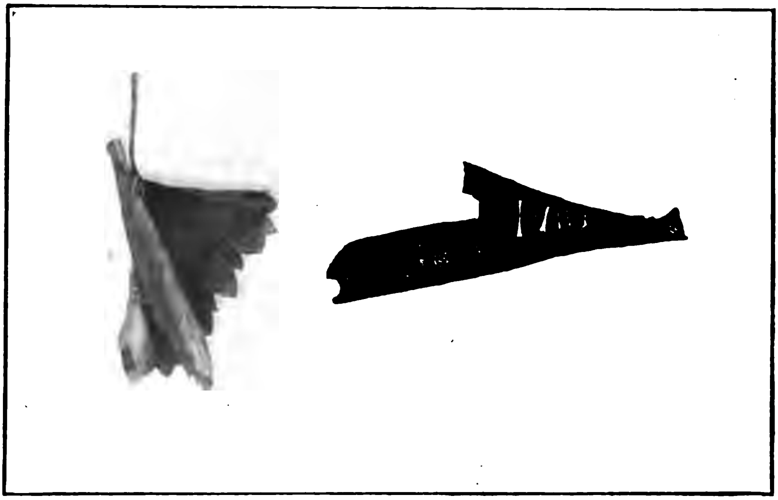
(*Eudemis botrana.*)

This insect was imported, many years ago, from Europe, and is one of the few insects affecting the grape that is not native to this country. The eggs are laid on the berries and as soon as the young larvae hatch they enter the fruit and begin feeding. The first sign of them in the fruit is a purplish spot on the side of the berry. The spot resembles, to a very marked extent, the appearance of the early stage of the Black Rot, and is often confused with this trouble. When the larva is full grown it emerges from the berry and cuts out of the grape leaves a little flap from which it forms an oblong case and in this case or cocoon it changes to a chrysalis. The adult moth appears in from ten to twelve days. There are several broods of this moth each year and the last brood passes the winter hibernating as a chrysalis in the cocoon. The first brood of moths that appear in the spring frequently live largely on the leaves and the young shoots. At this time they can be successfully combated by the employment of any arsenical spray. The injury to the fruit cannot be controlled by spraying, to any considerable extent, and the only means of combating it is to sack the grapes, as has been mentioned previously. It is of great value to promptly collect and burn all of the leaves when they are off the vines in the fall. In this way will be destroyed a great majority of the hibernating insects.

LEAF FOLDER.

(*Desmia funeralis.*)

The adult of this pest is a pretty black and white moth with a wing expanse of about one inch. The larva injures the leaves by eating the tissues and by rolling the leaves up to form a protecting case for it while it is not feeding. I have seen small grape vines on which practically every leaf had been tightly rolled up by this insect. The larva is about an inch long, green in color, and exceedingly active when disturbed, going through all sorts of contortions on the least provocation. This active wiggling when disturbed is doubtless for the purpose of frightening away the adults of the various parasite flies which are known to prey upon this and similar species. The insect winters as a pupa in the rolled leaves and is another insect which can be controlled to a certain extent by gathering the fallen leaves in the autumn.

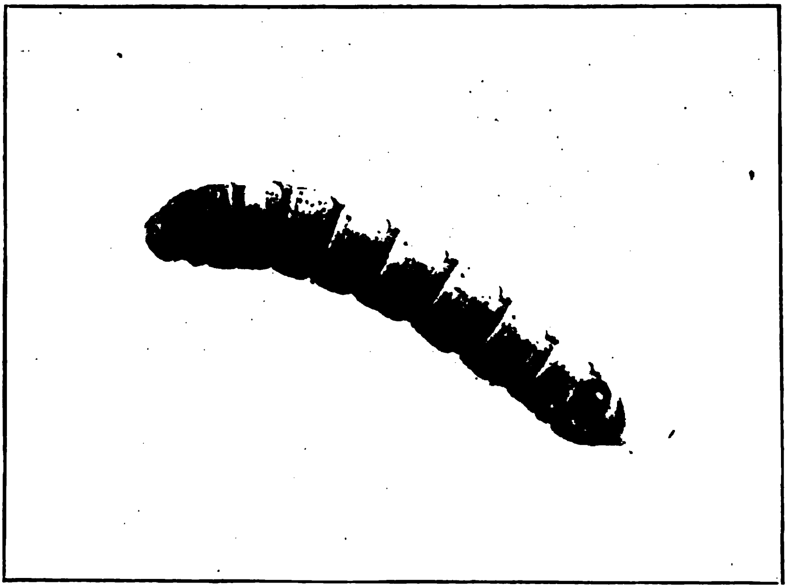


WORK OF GRAPE LEAF FOLDER.

GRAPE VINE SPHINX.

(*Philampelus achemon.*)

This large caterpillar sometimes causes serious injury to the grape vines by eating the leaves. As a rule all of the leaves on a single shoot are devoured, thus making the injury very conspicuous. For this reason the work of the insect is rather readily detected, and as the caterpillars are large they can be gathered by hand and destroyed. The caterpillars present an interesting variation of the true Sphinx Moths in that the larva shed the anal horn after the second or third moulting. In place of the anal horn is a curious eye-like spot, well shown in the accompanying illustration.



GRAPE SPHINX.

LEAF HOPPER.

(*Typhlocyba vitifex.*)

This is a small yellowish-green insect beautifully marked with bright colors. The Hoppers occur on the leaves of the vines and are very active, being capable of flying, running or jumping in a very lively fashion. The adults injure the leaves by sucking the juices from the interior of the plant, and when they occur in large numbers, as they often do, they are very serious pests in the vineyard. The adult insects hibernate in trash on the ground and in fallen leaves, and in the spring of the year lay their eggs in the tender tissues of the young leaves. The young are wingless and run or crawl very rapidly over the surface of the leaf, obtaining their food in the same manner as the adults. There are several generations during the summer and by midsummer the insects often occur in enormous numbers. They, of course, cannot be controlled by any arsenical spray, but must be combated by a contact insecticide. They are exceedingly resistant and a strong solution must be used if they are to be killed. Such strong solutions often result in some injury to the vines and it has been the practice to spray the insects with a mild contact insecticide which will not injure the vines. This will dislodge them from the vines and while they are on the ground they can be sprayed with a stronger contact insecticide to kill them. If the strong contact insecticide is applied directly to the vines it will cause leaf injury, while the milder solution will not kill the majority of the insects which it knocks to the ground. Clean culture in the vineyard and the destruction of all fallen leaves in the fall of the year, is of vital importance in the control of this pest. In this way is emphasized the value of thorough culture in the vineyard.

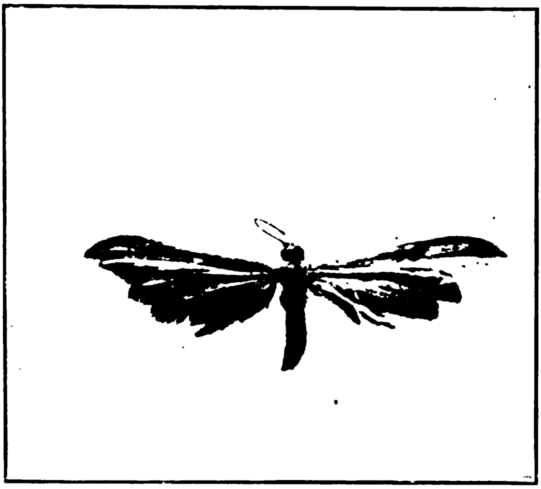
FLEA BEETLE.

(*Haltica chalybca.*)

This active little beetle is about a fifth of an inch long and is of blue or sometimes greenish color. The adults hibernate and appear in early spring to eat the opening buds of the grape. The eggs are laid on the leaves in clusters and are orange in color. The small larvae are of a brownish color, and are very voracious eaters, sometimes defoliating the vines on which they work. The young larvae, when they reached their growth, enter the ground to pupate, the adults emerging sometime in July. These adults pass through the winter and complete the life history. The insects are active leaf eaters and can be controlled by any arsenical spray. The fact that the adults hibernate in the fallen leaves also suggests that they can be prevented by clean culture in the vineyard. As far as insect control is concerned there is no other crop that requires more attention to the soil conditions than does the grape. A vast majority of the injurious insect pests and some of the fungous diseases can be largely controlled by the proper attention to the winter conditions of the vineyard.

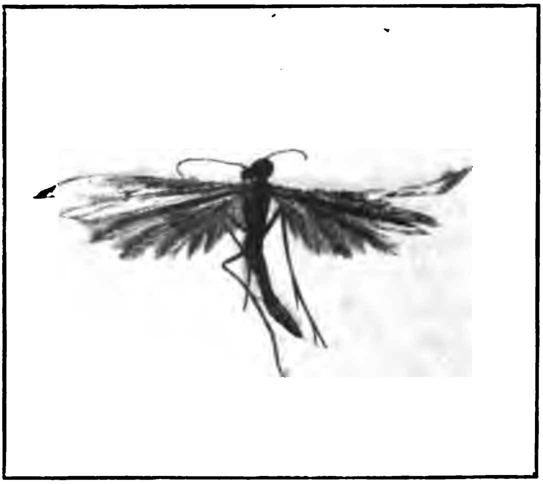
PLUME MOTH.

(*Oxyptilus periscelidactylus.*)



No. 1. Grape Plume Moth.

This pretty little moth is very common in some sections of the State and causes a certain amount of injury to the young shoots of the grape vine. The eggs are laid in the tip of the growing shoot and the larva destroys the growing bud and ties the leaves into a protecting cover in which it works. The adults are very readily attracted by light, and moth traps can be used very successfully in controlling them. In most sections, however, the insect is not sufficiently common to prove a really injurious form.



No. 2. Grape Plume Moth.

ROSE CHAFER.

(*Macrodactylus subspinosus.*)

The eggs of this small beetle are laid in grass lands in June and July. The larvae which hatch from the eggs feed on the roots of the grass and resemble in appearance the White Grubs, which are the larvae of various beetles belonging to the genus Lachnosterna. They are, however, smaller than the beetles of this genus. They reach their full growth in autumn and winter as larvae, pupating for two weeks in the spring of the year and appearing with the bloom of the grapes.

The adult beetles are light-brown in color and a little less than a half inch in length. They are long-legged creatures and are clumsy and awkward in their movements, being readily jarred from the plants on which they are feeding. This beetle has been called the "Rose Chafer," from its habits of feeding on the rose. The beetle might better be called the "Grape Chafer," as it is an exceedingly injurious form on the grapes in some sections. When it appears it usually comes in large numbers, and spraying with any arsenical preparation will have little effect owing to the enormous numbers of the insects present. There are comparatively few records of the injurious appearance of this beetle in Indiana, though in the last few years several cases have come to my attention. One interesting case was an infestation, not of grape vines, but of persimmon trees, where the beetles had practically ruined the persimmon crop by devouring the blossoms. On the grape the beetle eats the blossoms, the leaves, and later on the small fruit. It can best be controlled by using a catcher similar to the catchers used in collecting the curculio beetles on the fruit trees. These catchers are simply nets, into which the beetles can be jarred, collected and destroyed.

Controlling them in this way is practical, provided the jarring and collecting of the beetles is practiced regularly day after day. Like all methods of insect control, it must be thorough if it is going to be successful. It has been said that crude carbolic acid, at the strength of one to one thousand, will repel these beetles and not injure the foliage of the grape. I do not know of this solution having been tried in Indiana, but should the beetles occur it is worth the experiment.

GRAPE VINE FIDIA.

(*Fidia viticida.*)

This is a small, brown beetle, about a quarter of an inch in length and with the wing covers rather completely covered with yellowish hairs.

The adult beetles cause an injury similar to that of the Rose Chafer, by devouring the green parts of the plant. The larvae, however, live below ground and feed on the roots, causing by far the most serious injury to the vines. The eggs are laid in cracks in the bark and the young larvae crawl to the ground and at once burrow down to the roots. Enormous damage is sometimes caused by them. These larvae are full grown late in the summer and hibernate until June of the following year, when they pupate for two weeks, the adults emerging late in June or early in July. Any insect which works below the surface of the ground is a difficult form to control. This insect can best be controlled by spraying the vines with any arsenical preparation immediately after the appearance of the adult insects. This spraying must not be delayed or the beetles will lay their eggs and the larvae will reach the roots in the soil. When this occurs but very little can be done to save the vines.

GRAPE CANE BORER.

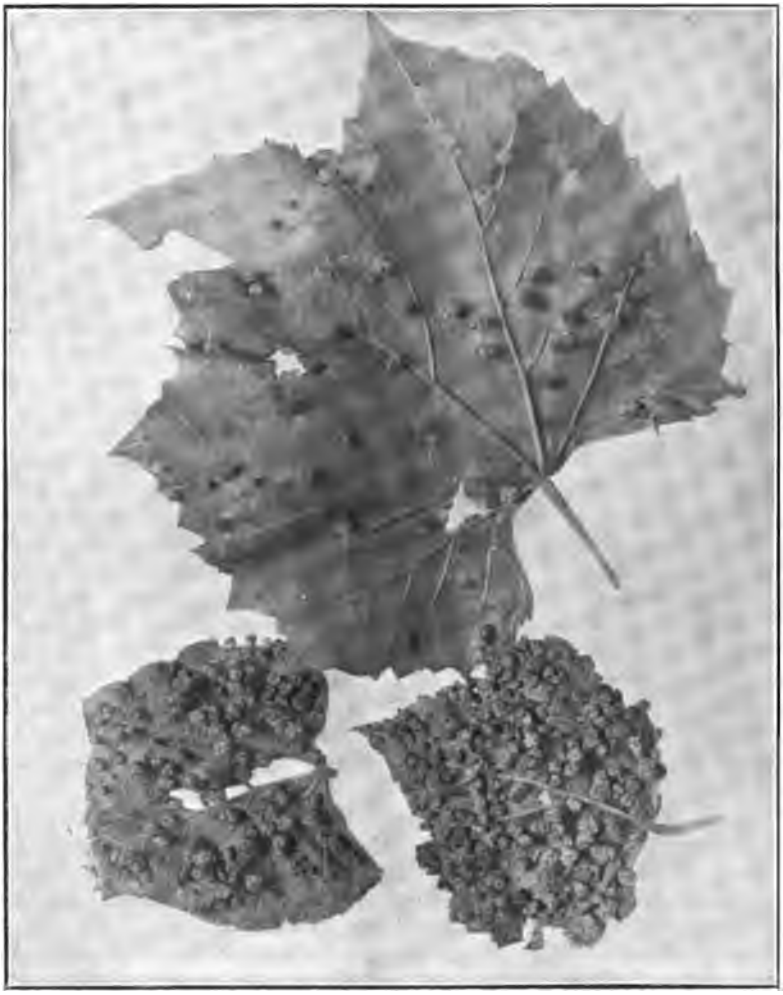
(*Amphicerus bicaudatus.*)

This small beetle injures the vines by boring into the cane at the base of the young shoots, causing the shoots to die. In some localities this beetle is of considerable importance and does great damage. It normally breeds in half dead wood or in large prunings. Consequently all unhealthy vines in the vineyard should be taken out and destroyed and all of the large prunings should be removed at once and burned. This same beetle sometimes bores in the twigs of apples and other fruit trees, though it is not a common source of injury in such situations.

GRAPE PHYLLOXERA.

(*Phylloxera vastatrix.*)

This is an American insect that does comparatively little damage to American vines. It has, however, been introduced in France, where for the past fifty years it has caused enormous damage. In



LEAF GALLS CAUSED BY THE PHYLLOXERA

that time more than two million, five hundred thousand acres of vineyards have been practically destroyed by this one insect. It injures the leaves and roots by forming small galls. The American varieties of grapes are but little bothered by this pest, but European sorts cannot be grown here successfully. By grafting European varieties on American roots it has been possible to rejuvenate the ruined vineyards of France. This is not an insect to cause any worry to the grape growers of Indiana, but the following life history is given from C. L. Marlatt's account in Farmer's Bulletin number 70:

"The life cycle of the Phylloxera is a complicated one. It occurs in four forms in the following order: The leaf gall (gallicola), the root or destructive form (radicicola), the winged or colonizing form and the sexual form. The leaf gall insect produces from 500 to 600 eggs for each individual, the root habiting insect not much above 100 eggs, the winged insect from 3 to 8, and the last, or sexed, insect but 1. This last is the winter egg and may be taken as a starting point in the life cycle. It is laid in the fall on old wood, and hatches the spring following into a louse, which goes at once to a young leaf, in the upper surface of which it plants its beak. The sucking and irritation soon cause a depression to form about the young louse, which grows into a gall projecting on the lower side of the leaf. In about fifteen days the louse becomes a plump, orange yellow, full grown, wingless female and fills its gall with small yellow eggs, dying soon after. The eggs hatch in about eight days into young females again like the parent, and migrate to all parts of the vine to form new galls. Six or seven generations of these wingless females follow one another throughout the summer, frequently completely studding the leaves with galls. With the approach of cold weather the young pass down the vines to the roots, where they remain dormant until spring. The root is then attacked and a series of subterranean generations of wingless females is developed. The root form differs but slightly from the inhabitant of the leaf galls and the swelling or excrescences on the roots are analogous to those on the leaves.

During late summer and fall of the second year some of the root lice give rise to winged females which escape through cracks in the soil on warm, bright days and fly to neighboring vines. These winged lice lay their eggs within a day or two in groups of two or four in cracks in the bark or beneath loose bark on the old wood of the vine and die soon after. The eggs are of two sizes, the smaller or fewer in number yielding males in nine or ten days, and the larger females of the only sexed generation developed in the whole life round of the insect. In this last and sexed stage the mouthparts of both sexes are rudimentary and no food at all is taken. The insect is very minute and resembles the newly hatched louse of either the gall or the root form. The single egg of the larva-like female after fertilization rapidly increases in size until it fills the entire body of the mother and is laid within three or four days, bringing us back to the winter egg or starting point.

This two year life round is not necessary to the existence of the species and the root form may and usually does go on in successive broods year after year, as in the case with European vines on the leaves of which galls rarely occur. Under exceptional circumstances all of the different stages may be passed through in a single year. The young from the leaf galls may also be easily colonized on the roots and it is probable that the passage of the young from the leaves to the roots may take place at any time during the summer. The reverse of this process or the migration of the young directly from the roots to the leaves has never been observed.

The complicated details noted above were only obtained after years of painstaking research, conducted by the late Professor Riley, in this country and many careful investigators in France."

ROOT BORER.

(*Memythrus polistiformis.*)

This insect has been reported as a destructive pest in some sections of the United States. I have never seen a specimen in Indiana and would like very much to have reports of the occurrence of this form. The following account is from Bulletin 110, of the West Virginia Experiment Station:

"*The Adult.*—The mature insect is a handsome moth, the sexes of which differ considerably in size. The males vary from five-eighths of an inch to three-fourths of an inch in length, and from one inch to one and three-eighths inches in expanse. The females are larger, measuring about seven-eighths of an inch in length and one and one-half inches in expanse.

The general color of both sexes is a dark, lustrous brown. The fore-wings are brown and the hind-wings transparent, bordered and ribbed with brown. The abdomen is circled at the posterior margins of the second and fourth segments with bands composed of orange and lemon yellow scales intermingled, the lemon-colored scales predominating in the front band and the orange in the other. There are also spots of similar colored scales on the throax at the base of the wings. As the moths grow old and worn with flight these markings are likely to disappear to some extent. The legs are reddish brown and the antennae of the males brown, marked with metallic colors, and those of the female metallic purple and bronze. The antennae of the males are delicately pectinate or fringed. The female has a little orange-colored tuft on each side of the tail and the male has two tufts on each side, the middle pair being longer than the other.

The Egg.—The egg is oval in outline, slightly flattened at the sides with one face evenly convex and the other marked by a deep longitudinal furrow, or groove.

The Larva.—It is in this stage alone that the insect is capable of doing any injury. When first hatched the larvae are very small, being only about one-twenty-fifth of an inch in length. They are whitish in color with brown heads, and are sparsely covered with stiff hairs. When full grown some specimens attain a length of one and three-fourths inches.

As soon as the young borer is out of the egg which, as stated, is on the ground at the time of hatching, it begins to work its way downward through the soil, evidently trusting good fortune to guide it to a grape root. The borer, after finding the root, first eats its way through the outer bark and then begins to excavate an irregular burrow, which at first is confined to the softer portions of the bark. At the beginning this burrow may encircle the root several times, but later, as the borer increases in size, it is made to run with the grain of the wood and may be extended either towards or from the base of the root.

The Pupa.—When the larva is full grown and ready to pupate it leaves the root and ascends to near the surface of the ground. Here it constructs a rough, elongate cocoon, from three-fourths to one and one-fourth of an inch in length, which is composed outwardly of grains of earth and excrement and lined with tough silk. Within this cocoon it transforms to a pupa of dark brown color with yellow bands encircling the abdomen. The cocoon stands perpendicularly in the ground, with the upper or head end beneath the surface. When about to emerge the moth works half the length of its pupa case out of the cocoon and then escapes from the case through a slit in the back. The discarded case is left with one end adhering in the cocoon and the other projecting above the ground."

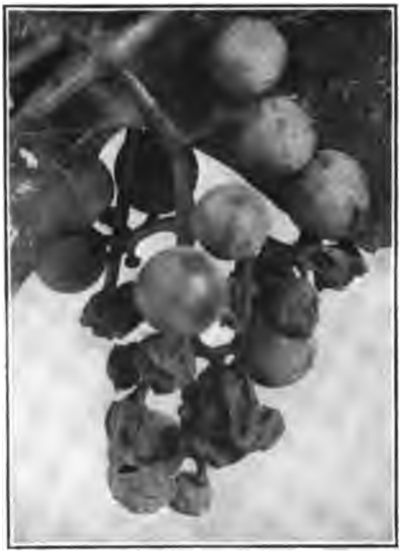
GRAPE DISEASES.

BLACK ROT OF THE GRAPE.

(*Guignardia bidwellii.*)

Grapes attacked with the Black Rot fungus first show the symptons on the leaves. Reddish brown, more or less circular spots appear. The spots show more plainly on the upper surface and often become one-half an inch in diameter. Very minute black, raised dots appear over the surface of the spot. Spores are discharged from these pustules in great numbers and are washed by rain or blown by the wind to other leaves and young fruit.

When fruit is attacked, small white blisters appear upon it. These blisters enlarge, turn brown, finally black, and completely cover the berries. At this stage it may be described as a soft rot. Later the fruit shrivels up and hardens and remains clinging to the cluster. When closely examined small black pustules, resembling those produced on the leaves, may be seen all over the surface of the dried up berry. Fruit is subject to attack at any time from the time the berries are formed until they almost mature. When very young fruit is attacked it does not cling to the cluster, but falls to the ground.

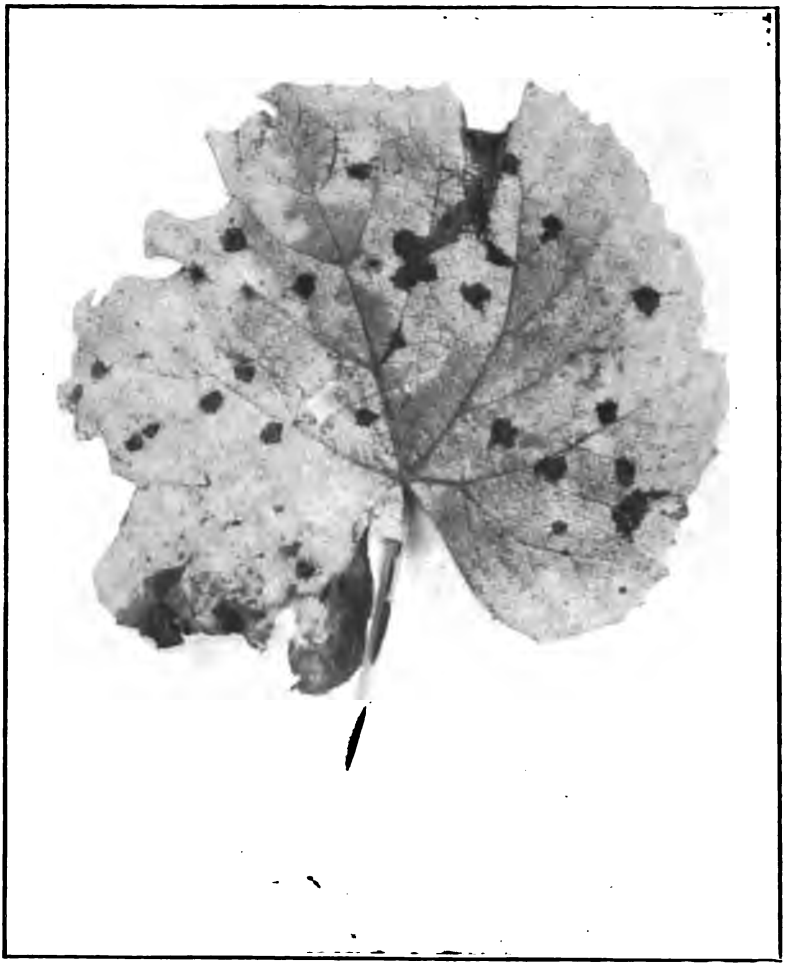


Black Rot on Grapes.

The evidence of disease on the stem is numerous small, reddish-brown spots along the stem. Often there is a tiny slit bordered by the spore pustules resembling those on the fruit.

It has been found that besides the spores which are formed and discharged in the summer, another kind of spores, known as "winter spores," are formed on the diseased portions during the winter and spring. These are commonly found on the mummied grapes, which often cling to the old clusters during the winter. These are the spores which start the first infection in the spring.

To control the disease action must be taken before the fungus spores gain entrance into the tissues of the plant. The first step is to rid the vineyard of any diseased material that may cause the spread of the disease. This means to remove all old clusters bearing mummied berries and also to destroy all prunings by burning, as these bear spore pustules. After this is done, if spots appear on the leaves in spring, a spraying with bordeaux or lime and sulphur should be made at once to destroy the first crop of summer spores and to prevent the attack on the young fruit. The aim is



BLACK ROT OF GRAPES.—LEAF SPOT.

to entirely cover the vine, shoots, foliage and young fruit with the fungicide,—thus preventing the growth of spores and their entrance into the plant. The times recommended for spraying are as follows:

First application—When the first leaves appear.
Second application—Just before the blossoms open.
Third application—When the blossoms have fallen.
Fourth application—After an interval of two weeks.

ANTHRACNOSE OF THE GRAPE.

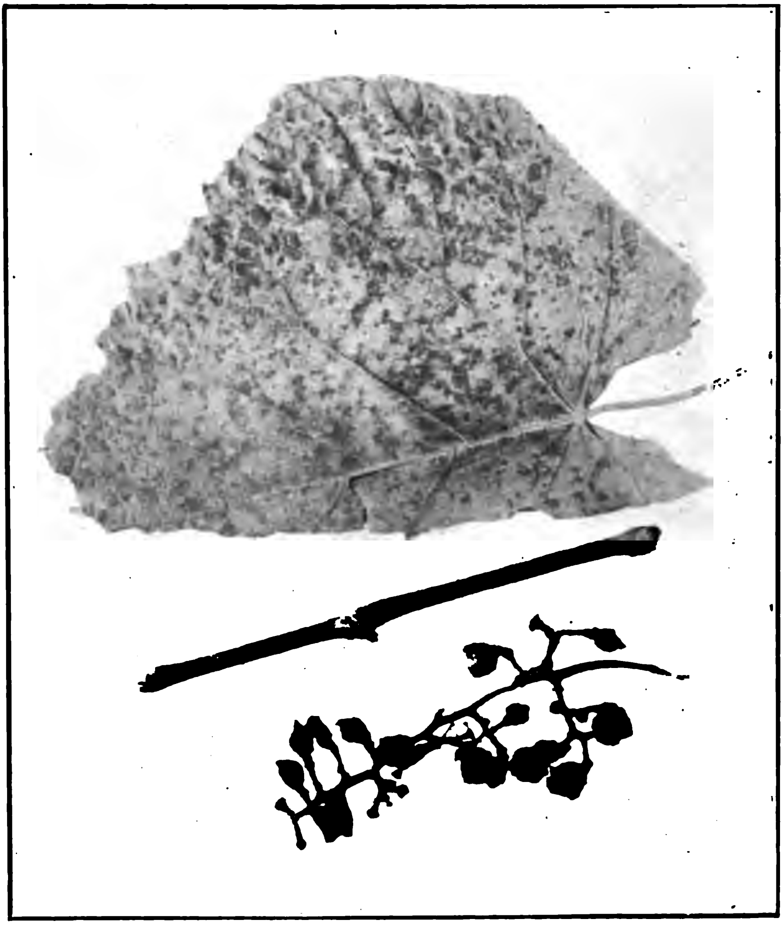
(*Gloeosporium ampelophagum.*)

The first signs of the disease are irregular, small, black patches on the new growth of wood, tendrils, cluster stems and young grapes. On the young shoots the spots elongate and the fungus eats down into the tissues and the shoots look as though holes had been burned in with a hot needle.

The leaf spot caused by the fungus closely resembles the spots formed on the shoots except that it is not depressed. Many small, black, irregular spots develop, often so closely placed as to almost cover the leaves. The early death of the leaves may result either from the direct injury to the leaves by the fungus or they may be killed indirectly by the stem cankers cutting off the water supply.

The really serious phase of the disease, however, is the injury to the fruit. When the fungus attacks the fruit hardly a perfect berry can be found on a cluster. On any one cluster the fruit spot may be found in all stages, from its first appearance as a tiny brown spot, with a grey center, to the last stage—the dried up mummy. The spots keep their regular outline as they enlarge and the center remains lighter and outlined with a narrow brown or red border. This is not a soft rot, and in this way can be easily distinguished from the Black Rot. The spots become hard, scabby, sunken and covered over with small black pustules. The berries finally shrivel up and dry, but throughout the drying process the spots can be easily recognized. The peculiar banded appearance and the circular shape has given the disease on the fruit the common name of "Bird's Eye Fungus."

The fungus probably lives over the winter in diseased canes and shriveled fruit. The canes should be pruned out and the mummied clusters removed in the fall. The disease is especially destructive when damp, chilly weather follows an early growing season. At



ANTHRACNOSE OF GRAPE.—LEAF SPOT AND MUMMIED BERRIES.

the approach of such weather prompt and thorough spraying with bordeaux, entirely covering the vine with the fungicide, will check the disease. In home vineyards, sacking while the grapes are still small will prevent the attack of this fungus on the berries.

DOWNEY MILDEW OF THE GRAPE.

This disease is also commonly called "Brown Rot" and "Grey Rot." The name "Mildew" comes from the appearance of the leaves and stems and the terms "Brown Rot" and "Grey Rot" from the effects of the disease on the fruit in two different seasons of the year.

When the fruit is attacked in early summer the growth is checked and the berries appear to be covered with a grey, mealy substance. This has given the disease the name "Grey Rot." When berries are attacked later in the summer a brown, rotted spot appears instead of the grey powder, and this has led to the name "Brown Rot."

The leaf effect of this fungus is more serious than the injury to the leaves from either Anthracnose or Black Rot. Small, sharply defined, light-green or yellow spots appear on the upper surfaces of the leaves. These spots very soon become brown and dry, and directly beneath on the under surface a downy growth appears. The spots are often so numerous that the upper surface of the leaves become almost completely covered with them and the under surface is covered with a growth of downy mould. This has given the name Downy Mildew to the disease. The leaves dry and curl early in the season, and, as a result, the food making capacity of the vine is diminished. The vine accordingly shows little growth and the grapes, even when not attacked by the fungus, are smaller in size and of inferior quality.

The disease is more serious early in the season and should be watched for and treated at this time. In the case of home vineyards, sacking will prevent the attack on the fruit. When sacking is not practical, spraying must be resorted to for the control of the disease.

The first application should be made about a week before the blossoms fall; the second a week later. This should be followed by another after an interval of about two weeks. If necessary, a fourth should be made three or four weeks after the third.

NECROSIS OF THE GRAPE.

(*Fusicoccum viticolum.*)

Necrosis is a Greek word meaning "death," and successfully describes this disease. It is a "dying of the vine." Unless carefully examined this would not be called a fungous disease.

The chief symptom is a gradual weakening and finally the death of the vine. The leaves are either small and closely crowded or show an unhealthy light-green color, and fall early in the season. Often the fruit does not mature, but dries on the cluster, or in more advance stages no fruit is set.

The trouble is due to a fungus working in the stem of the vine and clogging up the food and water conducting tubes with the fungous threads. If the green shoots are examined carefully, rusty brown spots may be found. Very minute pimples may be found in late fall on these spots. These are the spore pustules of the fungus. The spores mature in June and are discharged in thread-like masses from the opening in the top of the pustules. Rain and dew wash the spores to other shoots, and this is one means of spreading the disease. On the larger shoots irregular brown gall or wart-like outgrowths may be found.

As the disease is, to a great extent, within the stem of the plant, it is impossible to rid a vine of the disease when it is already affected. The only way to control the disease is to prevent new infection. Diseased vines should be dug out and burned. As the spores ripen the last of May, or the first of June, spraying at this time will destroy them and prevent the spread of the disease from this source. It is thought that much of the disease is spread by the pruning shears. Care should be taken not to prune healthy shoots at the time one is removing dead, diseased shoots.

MISCELLANEOUS INSECT NOTES.

THE HOUSE FLY.

(*Musca domestica.*)

I do not want to let an opportunity go by for saying something mean about the House Fly. These pests are of such wide and general distribution, and so extremely important in relation to public health, that I think a great deal of publicity should be given to methods of their control.

I do not believe that it is exaggerating the trouble to say that the control of the Housefly is the most vital problem in Economic Entomology in America today. It is likewise the most gigantic problem of insect control that has ever faced the world. The public is so indifferent to the occurrence of this filthy pest that many long years of education will be needed before the general public will be ready to recognize that something definite must be done against this distributing agent of typhoid fever and other intestinal diseases.

Following is an extract from an article prepared by the writer and published in the magazine, "Life and Health," last July:

"The house fly and its associates breed in filth of all kinds—stable manure, open vaults, neglected garbage, exposed flesh, such as cholera hogs, etc. The eggs are laid in this food material, the young hatch, and for a variable number of days are active feeding larvæ—maggots; when full grown they enter a resting stage. This period is also of variable length, but eventually the adult fly emerges.

From even a casual consideration of this life history it will be seen that the salient point of attack against this pest is at the larval or helpless stage. Flies must lay their eggs on material which is suitable food for the young or they would die out in a single generation. They must have filth in which to breed, and as long as we provide them with plenty of it, we are going to continue the spread of typhoid fever and other intestinal diseases broadcast over the land.

The measures for the control of this insect are comparatively simple. And this fact of their simplicity is one of the reasons why it is difficult to institute remedial measures. The average citizen has no faith in things which he can readily understand, and we cannot deny that there is a widespread desire on the part of the public to be fooled. The economic entomologists of the country have known for years that the most effective spray for the control of the San Jose scale is a simple mixture of lime and sulphur boiled for one or two hours. This information has been spread

FLIES ON AN ATTIC WINDOW.

broadcast, and yet the public is so intent on being fooled that the manufacture of quack spray solutions was never in more thriving condition than it is at present.

Simple, decent cleanliness about the stable, the open vault and the garbage can will do wonders for the control of the fly. There is no legerdemain about the matter at all.

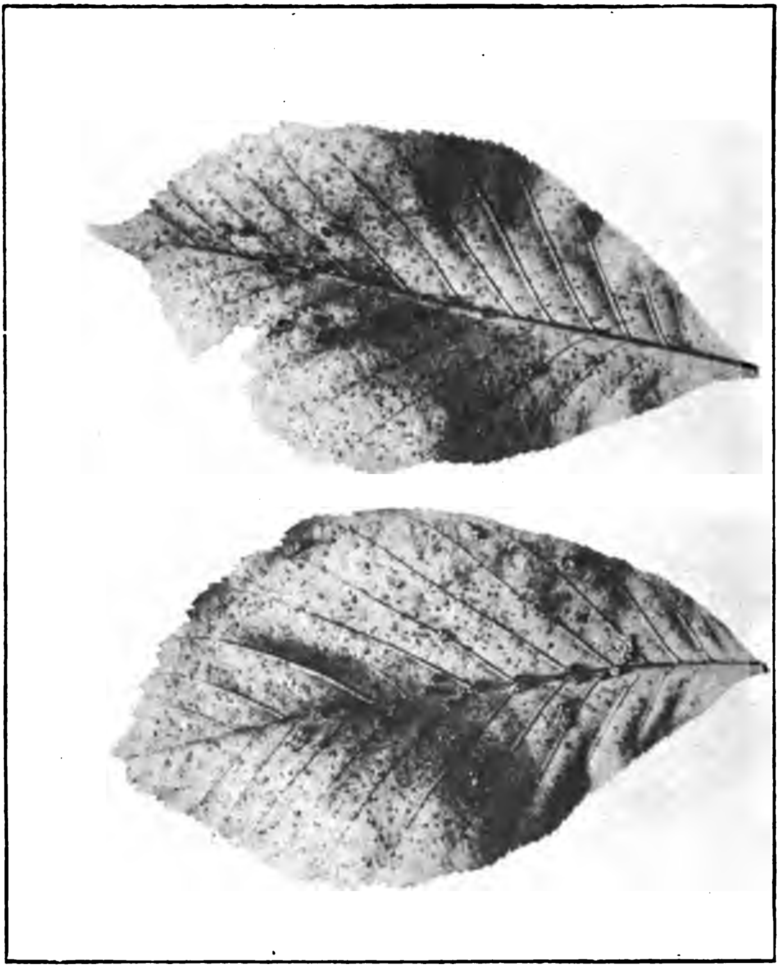
Last winter a farmer sent for me to come to his place and tell him how to get rid of a pest of flies. Such a call in the *winter* was unusual and I investigated with considerable interest. It was reported that the attic was "alive with flies" and that they were breeding there. I found that the number of flies had not been exaggerated. The windows of the attic were literally darkened with them. Breeding they were not, for the simple reason that they were tightly shut in the attic, and that the attic was perfectly dry and clean. The housewife was an excellent housekeeper and in all things under her control I found perfect order.

An examination of the insects showed that most of them were not house flies, but flesh flies and cluster flies. This latter insect is but little understood and is supposed to breed in wet earth.

A cross-examination of the owners of the farm revealed the fact that the previous season many hogs had died in the neighborhood from cholera, and that they had been somewhat neglected. This, of course, accounted for the unusual numbers of flesh flies in the neighborhood during the fall season. This excessive brood simply took refuge in the most convenient shelter it could find, which happened to be the farmer's attic.

The impression which the farmer had relative to the pests breeding in the attic had its origin in the fact that the flies were of different kinds and different sizes. I had some difficulty in explaining that when an adult fly emerges from the pupa case and dries its wings it has its full growth. The alleged "young ones" were adults of a smaller species."

During the past summer Dr. Simmons, of the State Board of Health, has called my attention to several cases of fly larvae infecting the human intestines. In one case, that of a Mr. Faber, of Sunman, Ind., the parasites were submitted to the Department of Entomology at Washington for identification. It was reported that the larva closely resembled that of a species of fly belonging to the genus *Sarcophaga*. One unusual thing about this insect was the fact that the larvae were present not only in the summer of 1909, but were also found to be present on September 17th, 1910, more than a year after the first date. Another case from Greensburg was reported on July the 30th, and the parasites proved to be the larvæ of a fly belonging to the genus *Homalomyia*. Still a third case, reported in July from Arcadia, developed the fact that two different genera of flies were in evidence. One of these proved to be the larvæ of the Rat Tailed Fly (*Eristalis tenax*). This same form was also found in the pupa condition in the same specimen. Likewise there was present a larva of a still different fly belonging



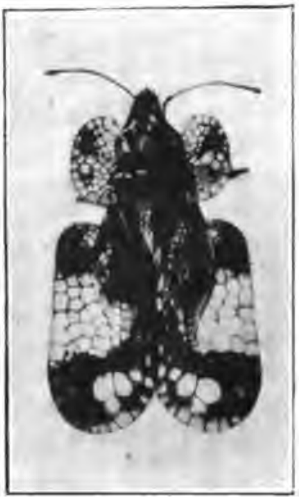
BUCKEYE LEAFLETS SHOWING THE LACE BUGS.

to the genus *Homalomyia.* Without having a complete record of any of these three cases, it is reasonable to assume that the insects found their way to the intestinal tracts by way of food taken into the body, which food contained the eggs, or possibly the very young larvae of the insect. Such infection might of itself prove fatal, and most assuredly might be the source of constant irritation and inflammation, and would be followed by far more serious intestinal troubles. The average citizen can understand a case of this sort very readily when he would not recognize the horror of having a filthy footed fly strolling over his bread and butter. The problem of fly control is a problem of cleanliness, and it is a problem on which the teachers of the public schools should labor with untiring diligence.

THE LACE BUG.

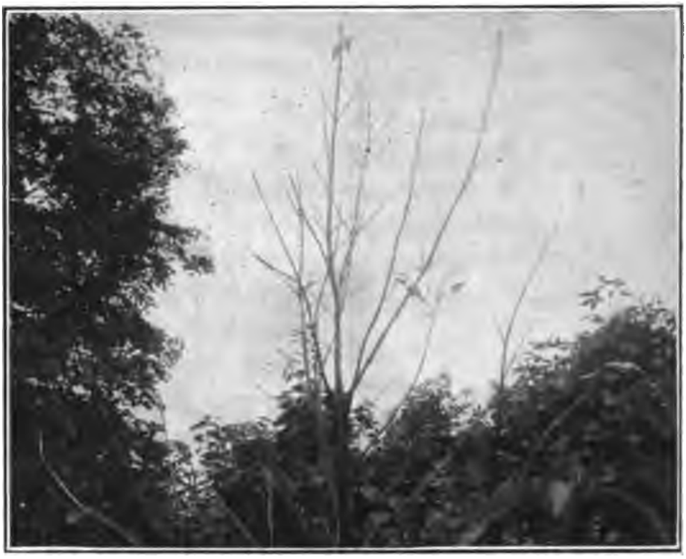
(*Corythuca sp.*)

Early in June many Buckeye trees in the northern part of Indianapolis were found to be infested with the Lace Bug. Many trees were so badly infested that by the middle of July the tops of the trees had been defoliated. Previous to defoliation many of the leaves turned brown and dried up, due to the fact that most of the leaf substance had been extracted by these pernicious sucking insects. The eggs are laid on the under side of the Buckeye leaflets and it is on the under side that the insects principally feed. The young bugs are wingless and crawl about over the surface of the leaf. By the middle of July many adults were present, and they could be readily jarred from the leaves, as they have a habit of playing possum. No attempt was made to control the insects by spraying, although they could have been killed by the application of almost any contact insecticide. Numbers of the young bugs were destroyed by the larvae of the Lace Winged Fly, an insect that was very much in evidence during the season.



Adult of the Lace Bug (Enlarged)

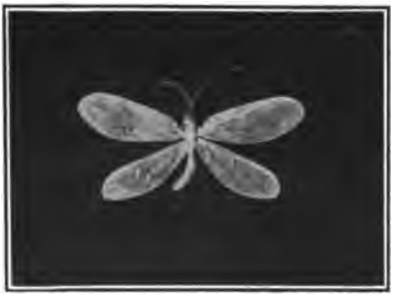
By August 15th, practically all of the Lace Bugs had disappeared, and by the first of September it was practically impossible to find a single specimen.



BUCKEYE DEFOLIATED BY LACE BUG.

LACE WINGED FLY.

(*Chrysopa sp.*)



Lace-Winged Fly.

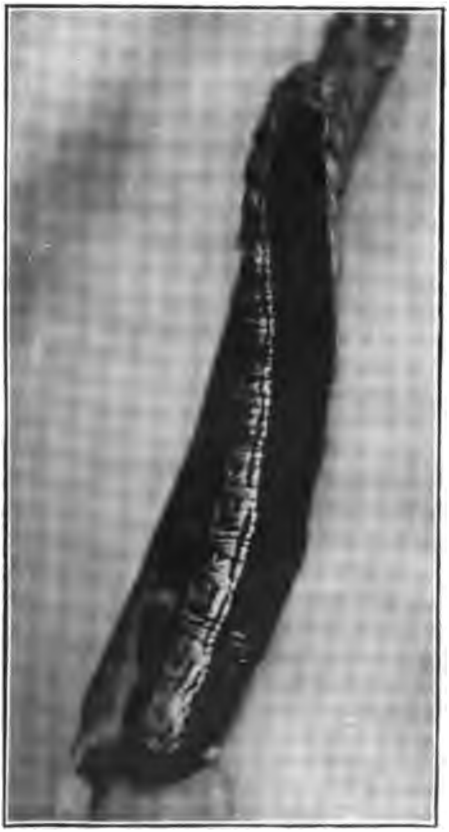
This beautiful little fly belongs to what are called the Nerve Winged Insects, owing to the peculiar venation of the wings. In the past season these insects have occurred in enormous numbers and have done a great deal of good in checking the ravages of several species of plant lice and some other small, soft-bodied insects. The eggs of this insect are laid on the top of a tiny stalk, about one-half an inch high, which is attached to the twigs of trees or to leaf stems, or to the surface of the leaf. When these eggs hatch the young larvae crawl down the stalk and make their way to the nearest plant lice that they can find. The plant lice are eagerly devoured by the larvae of this insect, and for that reason the Lace Winged Fly has been called the Aphis Lion. The larvae reach their full development in from ten days to two weeks, and then build a curious cocoon, which is almost perfectly round and of a shiny white color. This cocoon is remarkably small, considering the size of the larva that builds it and the size of the adult insect that eventually emerges from it. The adult is of a beautiful grass green color, the wings often iridescent with blue or yellow.

In spite of the fact that it is a beautiful creature the Lace Winged Fly is decidedly disgusting, owing to the offensive odor which it emits when collected. This odor is, of course, for the purpose of protecting it from birds, which will usually not touch it on this account. This is certainly a wise provision of nature, as the Lace Winged Fly is one of the most valuable insects that we have for destroying numbers of plant lice.

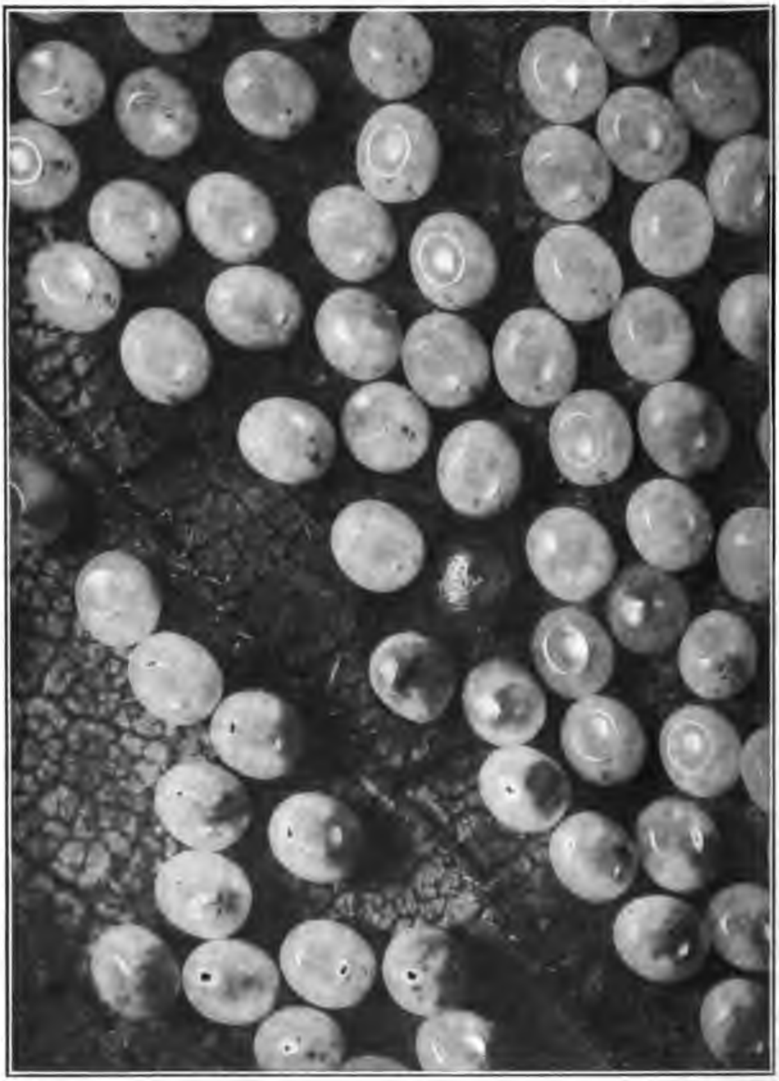
CATALPA SPHINX.

(*Ceratomia catalpae.*)

This insect has very general distribution over the portion of the State where catalpas are grown. In some sections the worms occur in such enormous numbers as to render it almost impossible to grow this species of trees. This is particularly true in the region of Greenfield, in Hancock County, where one plantation that I visited was practically killed by the repeated defoliation caused by this insect. Practically all of the catalpas in this district were almost ruined by the successive defoliations. The same conditions hold true of the catalpas planted along the Pennsylvania railroad, in the stretch between Richmond and Indianapolis. The insect is also noticeably bad in the lower Wabash Valley, and I have seen many plantations of catalpa practically ruined by this



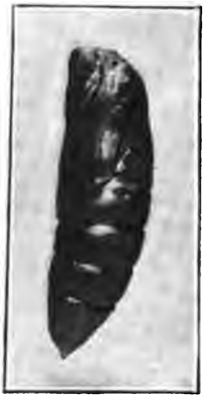
Full grown Larva of the Catalpa Sphinx. Notice the broad, velvety black stripe down the center of the back.

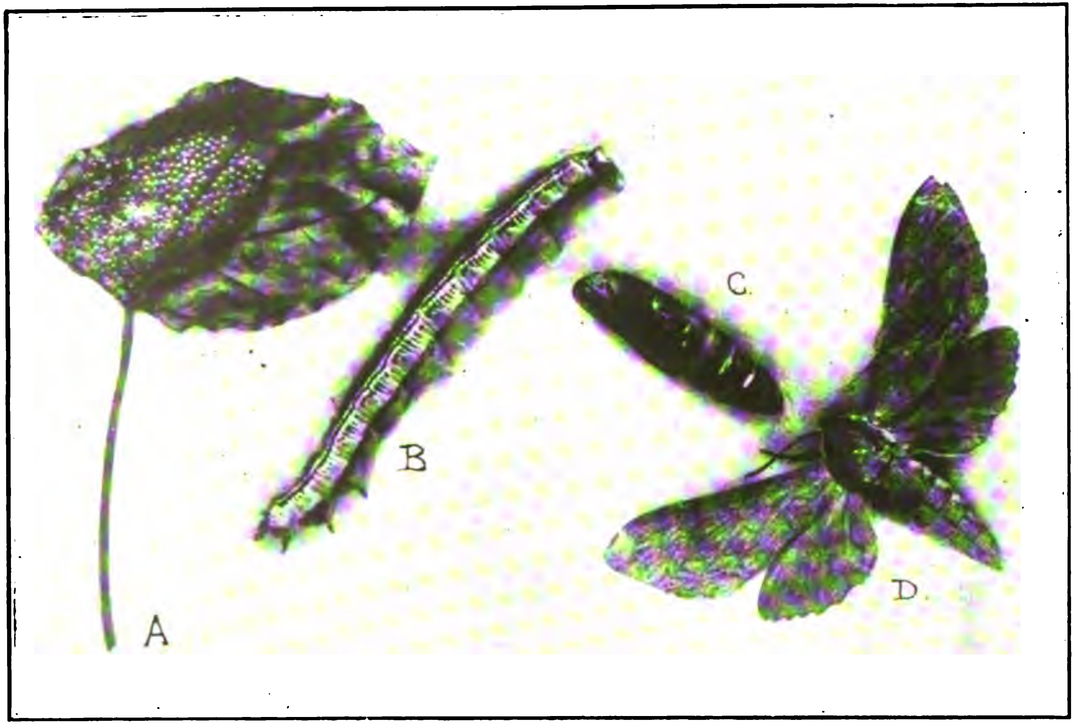


EGGS OF THE CATALPA SPHINX MAGNIFIED ABOUT TEN DIAMETERS.

pest. Single defoliations will not do much damage to any deciduous trees, but when defoliation occurs year after year it will result in the ultimate death of the tree.

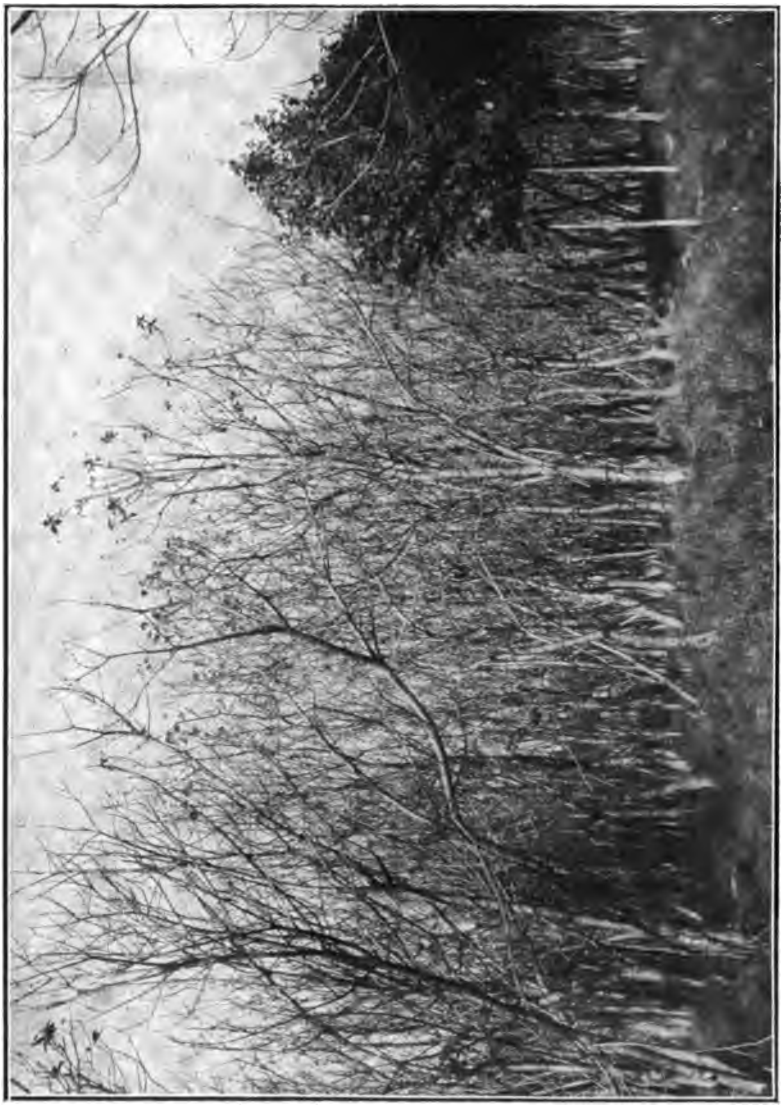
The eggs are laid on the under side of the Catalpa leaves. These eggs are laid in large, irregular patches, but are not piled indiscriminately one above another, as has been stated by some writers. The young larvae hatch and are gregarious in their habits, but as they grow older they separate and often feed singly. The young larvae show many variations in color markings, though when they reach their full growth they are nearly all marked with a broad stripe of velvety black running along the dorsal side, from the head to the tail. Like the Tomato Sphinx, this insect spends the pupa stage in the ground near the base of the trees. There are at least two broods a year in Indiana, and possibly a partial third brood, though I think it is probable that a large number of individuals of the second brood stay in the ground over winter. This insect is another, though I believe, superfluous argument against the planting of Catalpa trees.


Pupa case of the Catalpa Sphinx. Notice that while this is a Sphinx Moth, the pupa lacks the characteristic jug handle which occurs in nearly all the other members of this group.



LIFE HISTORY OF THE CATALPA WORM.

A—Egg cluster on leaf. B—Larva. C—Pupa. D—Adult.



A CATALPA PLANTING PRACTICALLY KILLED BY THE CATALPA SPHINX.

FORMULÆ.

LIME-SULPHUR WASH.

The lime-sulphur wash easily stands first among the contact insecticides, and is the most effective solution which we have for use against the scale insects. It is designed primarily for winter work, as it is so caustic in its action as to be almost fatal to any kind of foliage.

The following formula is one that has been thoroughly tested by this office and is entirely reliable:

Lime,	50 pounds.
Sulphur,	50 pounds.
Water,	150 gallons.

Add enough water to the lime to slake it thoroughly and immediately add the sulphur. Boil for an hour or so, with only enough water to keep the mass liquid, until the solution becomes a deep amber color. After it has all been mixed together, boil for at least another hour, and then add water enough to make up 150 gallons, and spray it as soon as possible. It is more efficient when used warm, and some of the failures with this wash have undoubtedly been due to the use of stale solutions and to careless boiling.

It is always advisable with this or any other spray to wear very old clothing that will never be used for any other purpose, and to protect the hands and face in some way. Automobile goggles would serve admirably to keep the spray from the eyes.

The lime used in the lime-sulphur wash should be unslaked stone lime containing just as little sand as possible. The "new process" lime will give excellent results, but lime and sulphur should never be used in a spray outfit which is operated with compressed carbon dioxide, as the carbon dioxide will precipitate the dissolved sulphur.

Commercial lime and sulphur can now be obtained from a number of reliable firms ready prepared in a concentrated form, ready to be applied to the trees as soon as it is diluted. As it comes from the factory this material costs about twenty cents per gallon in barrel lots. It is diluted one to ten, thus making a gallon of spray solution as it goes on the tree cost two cents. In large lots this cost can be reduced to one and seventy-hundredths cents per gallon.

This solution is fully as effective as the home-made preparation and the cost is practically the same. I would not hesitate to use such materials, and we accept the commercial solutions in place of the home-made solutions on spraying work ordered by the department. As a warning, I would say that no lime and sulphur solution should ever be diluted more than one to ten, or, at the outside, one to twelve. There are some preparations on the market that are said to do effective work at a dilution of one to twenty. I have tried one of these, known as Horicum, and have had practically no results with the San Jose scale. It might be that this solution would kill scale insects if it was not diluted so far, but if the manufacturer's directions are followed the preparation is practically worthless.

All of the commercial lime and sulphur solutions that we have used are in the shape of clear solutions, in color almost as dark as coffee, but of a more golden hue. There should be little or no sediment.

These solutions are now recognized as among our best fungicides for summer use. For this purpose they are used much more dilute than for the control of scale insects.

MISCIBLE OILS.

The so-called "miscible" or "soluble" oils are simply convenient preparations of some heavy oil mixed with a "cutting" agent to cause the oil to spontaneously emulsify when mixed with water. There are a number of preparations on the market under the name of Target Brand, Scalecide, Liquid Soap, etc. As a general rule, it is a good plan to use these solutions stronger than the directions call for.

I have found these proprietary scalecides especially valuable for summer use against the plant lice and even against some of the scale insects. Diluted with thirty parts of water but little foliage will be injured and the plant lice will be readily killed, and even the San Jose scale will be readily checked.

Miscible oils are objectionable as scalecides for several reasons. In the first place they are more expensive than the lime and sulphur solutions, and in the second place they are less effective as scale destroyers. It has also been claimed that the miscible oils sometimes injure the trees to which they are applied. I think that this might happen under certain weather conditions.

TOBACCO.

As a mild contact insecticide Tobacco possesses distinct value and may be used in a variety of ways. For plant lice a solution may be made by boiling stems or refuse in the proportion of one pound of stems to a gallon of water. This solution is not injurious to foliage except when it is very young. Tobacco dust is often useful against plant lice and certain slimy larvae, commonly called slugs. It can be used freely without danger of injury to the plants.

Coarse ground tobacco may be used around the roots of any plants affected with aphids, and it will have the double effect of an insecticide and a fertilizer. Certain Kentucky firms are now specializing in a complete fertilizer, in which tobacco is the filler. Doubtless it will prove distinctly beneficial for root lice, grubs and similar root infesting insects.

STOMACH POISONS.

Arsenate of Lead.—This preparation is not as safe an insecticide as Paris Green, owing to the fact that it lacks the latter poison's characteristic color. It is valuable as an early spray for apples, owing to the fact that it does not wash off the tree readily. It is less liable to burn the foliage.

It is prepared as follows:

Arsenate of soda,	20 ounces.
Water,	2 to 3 gallons.
Acetate of lead,	3½ pounds.
Water,	3 gallons.

When the chemicals are dissolved, the two solutions are mixed and water is added to make 100 gallons.

This preparation can be obtained in the form of paste, ready to be mixed with water. This form of the poison is more convenient and just as effective as the home-made article. When Arsenate of Lead is used in connection with fungicides containing lime and sulphur, care should be taken to see that the Arsenate of Lead is neutral and not too acid. There are two forms of Arsenate on the market, and it has been found that the acid form tends to cause a too rapid decomposition of the sulphur solution. By the use of litmus paper, obtainable from any druggist, it is possible to determine whether any particular sample of the paste is acid or neutral.

Paris Green.—Paris Green should be used at the rate of one pound of poison to 100 or 150 gallons of water, though it is often used stronger than this. Always add a quantity of lime at least equal to the quantity of Paris Green.

This violent poison can be more safely used on nearly ripe fruit, or on such plants as cabbage, than any other arsenical preparation, as it is more easily washed from the plant tissues by the rain. As a matter of fact; however, the poison is so diluted when it is applied that a man would have to eat an enormous quantity of fruit to get any effect from the arsenic.

SELF BOILED LIME AND SULPHUR.

The experience of the last year has placed this wash among the leading fungicides. There are two things to keep in mind when using any lime and sulphur preparation, 1, *always* strain them before putting them into the spray tank; 2, do not use carbon dioxide as the means of power in the spray tank, as it combines directly with the hydroxide of lime, forming carbonate, and thus precipitating the sulphur, making the wash useless.

It is prepared as follows:

Place 15 pounds of lime in a fifty-gallon barrel and pour 3 gallons of boiling water in it. At once add 10 pounds of sulphur and 3 gallons of water hot. If it shows any signs of sticking stir with some more water. This will boil vigorously for about twenty minutes. Then fill the barrel with cold water and use the spray at once.

The commercial lime and sulphur solutions have proved to be an excellent fungicide, and, while their use dates back over a very few seasons, I do not hesitate to advise their use to the exclusion of Bordeaux mixture. In my last report, I suggested that they might prove valuable along this line, and our experience during the past season has convinced me that the grower will not make any mistake in using them in place of Bordeaux in the future.

The objection to Bordeaux has been the russetting of the fruit. In some seasons this is worse than it is at other times. In our experiments this year we found that the trees sprayed with Bordeaux mixture were badly affected, practically every fruit being traced with the russet marks. This Bordeaux damage, as it is called, prevented the fruit from reaching as high a color as it did on the trees sprayed with the lime and sulphur.

The commercial lime and sulphur gave us good results on some varieties, diluted as much as one to seventy-five, although most of the work was done at a dilution of one to thirty. This strength was uniformly effective in preventing all fungus damage and it caused only a nominal amount of leaf burning. A preparation known as Sulfocide, which appeared to be a very concentrated sulphur solution, was effective in preventing injury to the fruit, but it also damaged the leaves badly on some varieties. It appears to offer no advantage over the commercial lime and sulphur or the home-made self-boiled lime and sulphur.

A complete review of these experiments is to be found in the account of the Newhouse orchard, on page 85.

BORDEAUX MIXTURE.

The first requisite in making any spraying material is the use of good ingredients. This holds good here. The quantity of the lime used may influence the resulting mixture to a great degree. The more finely powdered it is, and the greater proportion of calcium oxide present, have a great deal to do with the length of time that the precipitate will remain suspended. Do not use air-slaked lime.

Formula for Bordeaux Mixture.

Copper Sulphate, 6 pounds.
Lime, 4 pounds.

The copper sulphate and lime should each be made into solutions with a couple of gallons of water for each. Then dilute separately to make 25 gallons of each. Then combine, making 50 gallons.

If it is so wished, each solution may be kept in some suitable stock tank and drawn off and mixed directly in the sprayer.

AMMONIACAL COPPER CARBONATE.

This solution may be used wherever Bordeaux is used. It possesses some advantages. It is a clear liquid and is as easily worked as water and will not discolor fruit upon application just before maturity. In this respect it finds its greatest usefulness in spraying such fruits as grapes, which cannot be easily wiped before marketing. It may be made as follows:

Copper carbonate, 1 ounce.
Ammonia (26 deg. Beaume.)

Dilute with seven or eight volumes of water.

Enough used to dissolve the Copper Carbonate. Dilute with water to nine or ten gallons. In making the solution it is best to use utensils with no metallic surface, such as wooden pails or enameled ware.

BEEKEEPING IN INDIANA.

GEORGE S. DEMUTH,
Chief of the Division of Apiary Inspection.

"I often wonder what beekeepers buy one-half so precious as the stuff they sell."

That beekeeping should have been a very early branch of agriculture is a fact little to be wondered about. From Bible times, when locusts and wild honey formed no mean diet, down to the present, the product of the bee has been one of the most sought for and one of the most valued of luxurious foods. It *is* a matter of surprise, however, that beekeeping, as a branch of agriculture, should not have advanced more rapidly. In the past fifty years there has been more progress in apiculture than there has been in all of the centuries of previous beekeeping. Most of this progress, too, can be accounted for by the activity of the American beekeeper, whose efforts have placed beekeeping on a proper plane in respect to other branches of American agriculture. This fact is all the more interesting when we realize that honey bees are not native to this continent, but have been introduced from abroad. The wild bees of the woods are simply swarms that have absconded and returned to their original condition—for bees are scarcely to be termed "domesticated." The law considers them "feræ naturæ," or wild by nature, and the best that man has done has been to provide for them tolerable habitations, where they will remain and submit, to a certain extent, to his manipulations.

Man, by skilful management, has rendered beekeeping not only possible, but profitable, but he has not tempered the sting of the honey gatherers, nor dulled that instinct which sends swarm after swarm to seek new homes in hollow trees.

The majority of bees in Indiana are simply *kept*—not managed nor controlled. If the annual loss from lack of management could be computed it would reach a total that would be astonishing.

The annual loss caused by the ravages of Foul Brood, though enormous, is probably very small compared with the loss from want of proper management. It has, therefore, been thought best to include in this report an outline of a season's management.

Since no two seasons are exactly alike, and also as localities

THE KIND OF AN OUTFIT SOMETIMES FOUND EVEN IN INDIANA.

Such beekeeping is more than a half century behind the times.

differ as to nectar producing plants, no fixed rules for a season's management can be given, and this outline must be understood as being merely suggestive. No rules can take the place of the skill of the beekeeper, for new problems will be met each season. Circumstances may arise in a day that will necessitate a radical change in the system of management, so considerable experience and a thorough knowledge of bee nature are essential to the best results. There are, however, certain general principles forming the basis of proper management which, if violated, always bring failure, and which, if well understood, should lead to success.

Since White Clover is so widespread throughout Indiana, and constitutes the chief source of nectar, this outline is written largely from the point of view of the beekeeper in a clover locality.

The basic principles, however, remain the same for any locality, but the details of the various manipulations must vary with the location.

The beekeeper must, therefore, know first of all which plants may be expected to furnish the nectar for his honey crop before he can work out a system of management adapted to his particular locality.

It is well that the beekeeper have well in mind that the entire crop of surplus honey for the year is usually stored within a few weeks and sometimes within a few days.

In Indiana there are two distinct honey flows during which the major portion of the honey is stored. The first and most important comes during June and July from clover and basswood. Storing during this period is usually rapid and the honey is white. The second, or fall flow, usually begins in August, and sometimes lasts until frost kills the flowers. Storing during this period is less rapid and the honey is ordinarily amber or dark in color.

In some localities there are no fall flowers and consequently no fall flow, while in others there may be no early honey. A few localities are favored with both the early and the late nectar producing plants.

While the bees may gather some nectar from the time the maples bloom in the spring until the latest nectar producing plant is killed by freezing, it is only during these two periods, known as the early and the late honey flows, that the bees are likely to gather much more than their daily needs. In fact, during much of the time, even during the summer, they are compelled to draw upon their stores for their living.

It will thus be seen that the management of the bees during the entire year must be such that will bring about the proper conditions for the rapid storing of honey during the periods mentioned above, called the honey flows.

It sometimes happens that the bees are kept and cared for during three hundred and sixty non-productive days of the year for what they may do during the five days of honey flow. Such a short season would, of course, be pronounced a failure, but the beekeeper who is ready for the flow when it comes and manipulates properly, may harvest a fair crop even from so short a flow.

Almost any kind of management will result in the production of *some* honey during a good season, when the flow is of long duration, but to secure a crop of honey from the short and rapid flow, which we frequently have from clover or basswood, requires considerable skill and foresight.

If a colony of bees has its brood nest crowded with bees at the beginning of the honey flow, and a large force of bees to work in the field, it is ready to begin work in the super at once, simply because there is no room to store honey in the brood frames. If the flow were of but two weeks' duration and the above condition of the colony were not attained until it was practically over, no surplus could be secured. Thousands of colonies of bees are kept year after year, yielding their owner no profit, simply because their brood chambers are not thus crowded with brood and workers until the close of the honey flow and the nectar is left in the field because of lack of workers for the harvest.

It will thus be seen that securing a crop of honey depends not only on the quantity of nectar in the flowers, together with the weather conditions, but also on the condition of the colonies at the time the honey flow begins.

Since the condition of the bees at the beginning of the early honey flow depends largely upon their condition the previous fall, it is obvious that the foundation of a season's honey crop is built during the preceding season. For this reason an outline of a season's management may well begin with late summer and fall management.

LATE SUMMER AND FALL MANAGEMENT.

The eggs that produce the workers which survive the winter are laid during August and the forepart of September. It is therefore highly important that each colony contains a vigorous queen and plenty of honey during this time, in order that brood rearing may be normal.

After the early honey flow, if there has been much swarming, there will probably be quite a percentage of queenless bees, among the old or parent colonies. Such a colony has either lost its young queen before she began laying, or she has failed to become fertilized. Since there is no young brood from which the bees might rear another queen, such a colony is hopelessly queenless. And without the aid of the beekeeper the colony would dwindle and die from want of young bees to replace the natural loss from death.

If there are no eggs or larvae found in the hive three weeks after the swarm issued, a frame of brood may be given, and if the colony is queenless they will construct queen cells. It is then best to give them a laying queen, or a cell that is nearly ready to hatch.

All old and worthless queens may well be replaced in July. Many beekeepers even find it profitable to requeen all colonies each year.

If the locality furnishes a fall flow the supers should, of course, be put on and the crop harvested in the usual manner.

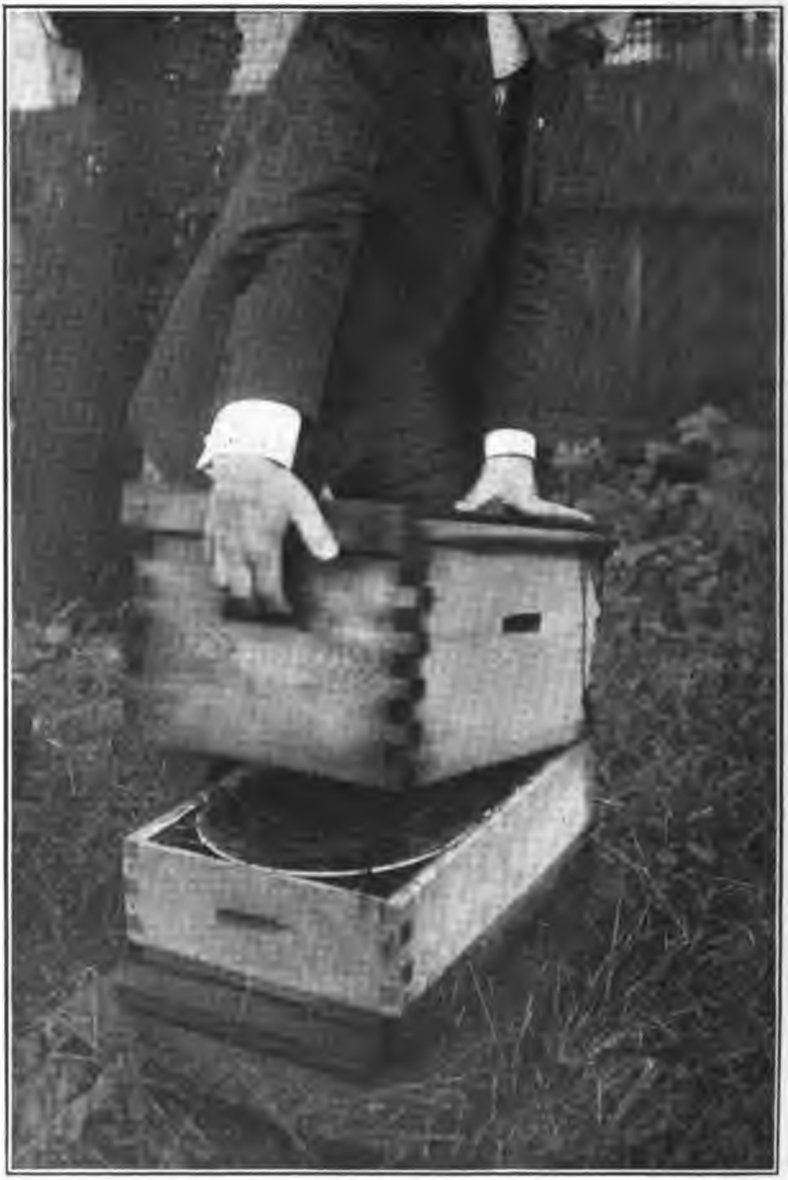
The essentials for midsummer and fall management are:

1. *Each colony must have a good laying queen during August and September.*
2. *Each colony must have sufficient stores that brood rearing need not cease because of lack of stores.*
3. *Each colony must have enough bees to care for at least six or seven frames of brood.*
4. *Harvest the fall crop if there be one.*

PREPARATION FOR WINTER.

After the frost has killed the flowers any supers that have been left on the hives during the fall flow should be removed and the bees prepared for winter.

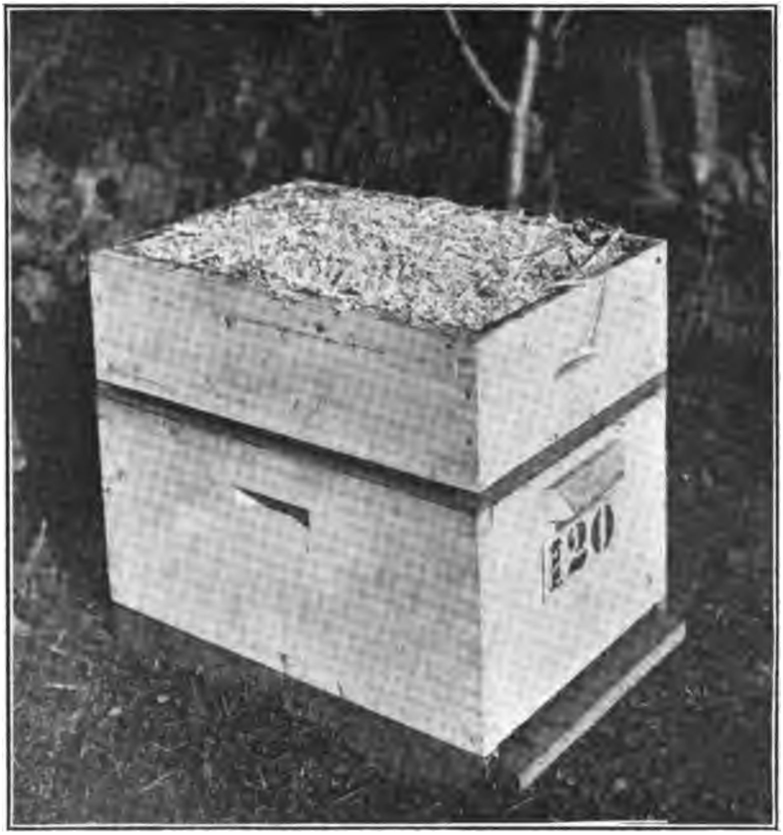
Each hive should be lifted or weighed (weigh them if in doubt) to ascertain the amount of honey. An ordinary eight or ten-frame, dove-tailed hive (without the super) should weigh not less than fifty or sixty pounds, when properly supplied for winter. Any that



FEEDING PAN IN POSITION.

weigh less should be marked and the shortage made up by inserting frames of honey, or by feeding sugar syrup.

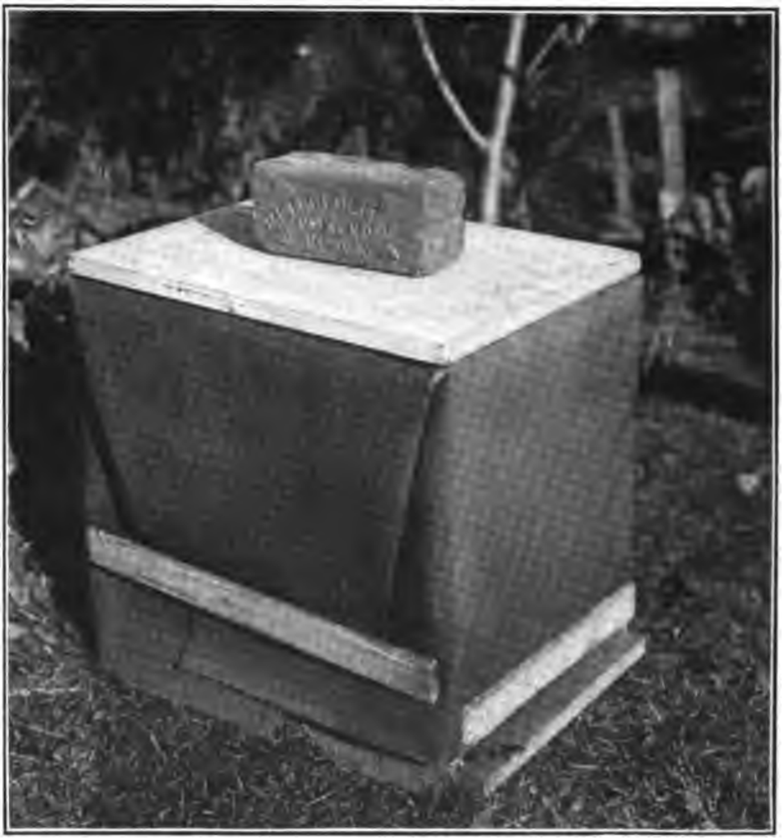
Combs of honey for feeding purposes are secured by placing a hive body, containing frames of foundation or comb, over a colony during the honey flow. When these combs are filled and sealed they may be removed and stored for future use. This is probably the cheapest and most convenient method of feeding. *Never feed honey unless it is positively known that the colony that stored it was free from disease.*



HIVE PACKED ON TOP READY FOR PAPER.

If no combs of honey have been saved and the colonies are found to be short of stores, they should be fed a syrup made of granulated sugar and water. Use two parts by weight of sugar to one part of water. If feeding is done very late, two and one-half parts of sugar to one of water would be better.

Heat the water to the boiling point, then add the sugar and stir, still applying heat, until the sugar is all dissolved. The addition of an even teaspoonful of tartaric acid to each fifteen or twenty pounds of sugar used will help prevent the granulation of the syrup in the combs. Feeding for winter should be done after brood rearing has ceased, usually during October. This prepared syrup should be given to the bees while it is still warm.



SAME HIVE AS PRECEDING, COVERED WITH WATERPROOF BUILDING PAPER.

This method of packing gives good results in southern portion of the State.

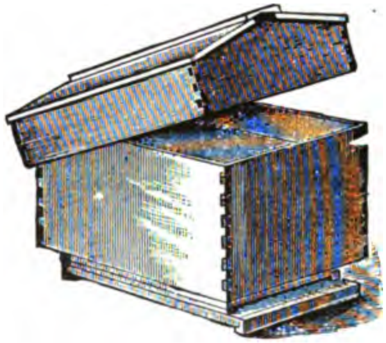
An excellent feeder can be made by using a large tin pan placed in an empty super. A handful of grass thrown on the syrup affords standing room for the bees and prevents their being drowned. If the feeding pan is placed directly below the cluster the syrup will be taken up within a few hours. Feeding from below renders it unnecessary to loosen the cover, which the bees have sealed down for winter.

Now if each colony had a good laying queen and plenty of brood in August and has, at the beginning of the winter, twenty-five or thirty pounds of good, wholesome stores, they have the two most essential factors for good wintering. About all that can be done in addition is to arrange the hives that the bees may be kept as warm and as dry as possible and see that they are exposed to the sun and sheltered from the cold winds.

The hives should never be left during the winter with no other protection on top than that afforded by the hive covers. They should be further protected, *on top at least,* by some non-conducting material, such as dry sawdust, planer shavings or cork dust. This packing material must be kept perfectly dry, for wet packing is much worse than none at all. The amount of packing for best results depends largely on the latitude and on the exposure to cold winds.

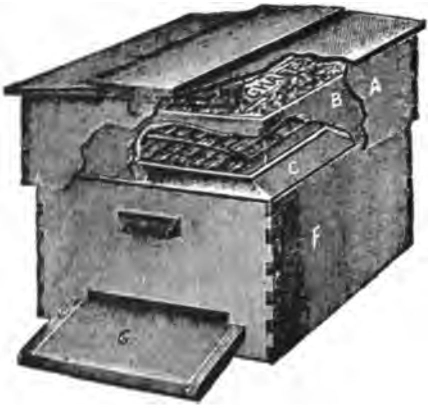
In the southern portion of the State, if the hives are in a sheltered place and are exposed to the sunshine, packing on top only gives good results, but in the northern portion, packing on both top and sides is advisable. In any case the bees should be so arranged that the sun may shine upon the entrance to dry out the moisture that may condense there.

The cluster of bees gives off considerable moisture during the winter and some provision must be made for its removal from the hive. Some beekeepers accomplish this by removing the cover entirely, covering the brood frames with a piece of cloth, above which, in an upper story, they place dry wheat chaff or leaves to a depth of six or eight inches.



Winter case that has a space for packing material at the sides as well as the top of the hive An excellent arrangement for the northern portion of the State.

This packing absorbs the moisture and largely prevents the escape of heat. When this method is used there must be a space between the cover and packing material and an opening allowing a free passage of air from this space to the outside of the hive that the moisture from the bees that has been absorbed by the packing may escape.



A double-walled hive with permanent packing at the sides.

Another method which gives equally good, and perhaps even better results, consists in leaving the wooden cover sealed down tightly with heavy packing above, and either light packing on the sides, or none at all. With this arrangement the moisture condenses near the entrance of the hive, where it soon dries up. The floor of the hive should, of course, slant forward, that the entrance may be lower than the floor. The entrance should not be more than three-eighths of an inch deep during the winter.

If, through neglect, weak colonies are on hand at the beginning of winter, enough such colonies should be united to form one strong colony.

If the stores are largely of honey dew or inferior honey, each colony should be fed at least ten pounds of thick sugar syrup, rather late,—after brood rearing has ceased. This syrup will be stored in the central portion of the brood nest in the cells recently vacated by the hatching brood and will thus be used first, while the honey dew will be left until the bees can fly in the spring, when it can be safely used.

Wintering the bees in cellars has some advantages, but in our latitude it is not advisable except in the hands of an experienced beekeeper.

The greatest difficulty with cellar wintering in Indiana is in keeping the temperature low enough during warm spells. With a special repository and some experience, however, cellar wintering gives uniform results with a minimum expenditure of stores and bee energy.

The essentials for successful wintering are:

1. *Strong colonies.*
2. *Plenty of good food.*
3. *Protection.*

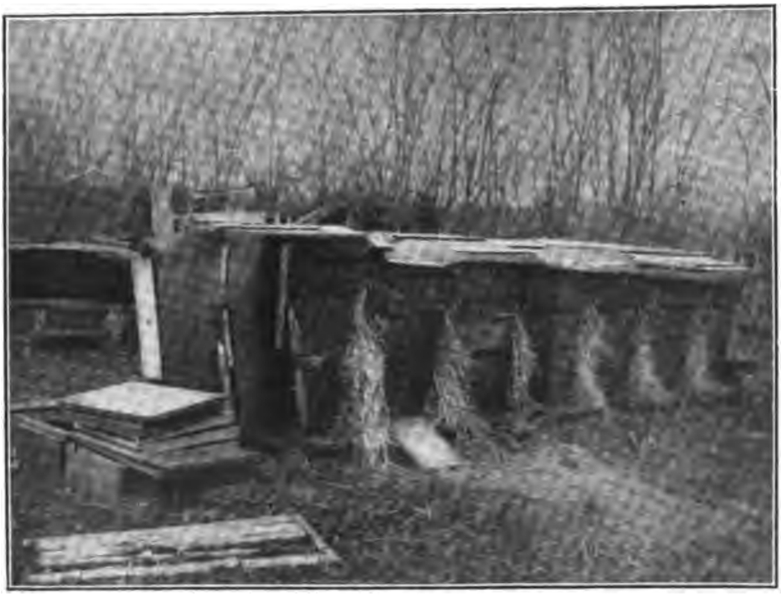
If the winter loss should be greater than an average of five per cent. of the colonies, something is wrong and the beekeeper should study carefully the conditions to find the cause of the trouble.

SPRING MANAGEMENT.

If the bees have wintered well there is but little that needs to be done in the spring. In fact, if each colony has a good queen and plenty of stores and a hive that will conserve heat, they may well be left alone until warm weather.

Covers should not be removed in early spring unless necessary, since breaking the propolis, by which the cover is sealed down, allows heat to escape.

If any very weak colonies are found, their entrances should be blocked down, leaving only space enough for one or two bees to pass at a time.

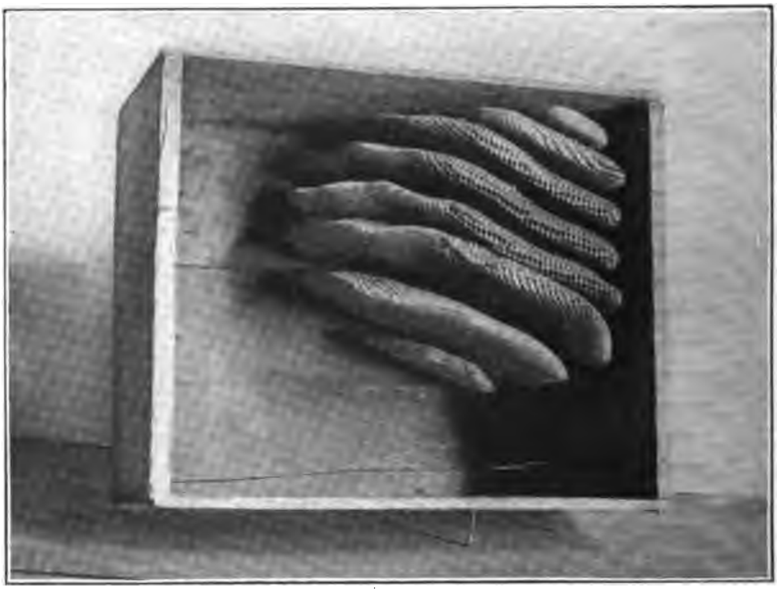


TENEMENT METHOD OF PACKING.

Note that the fronts of the hives are left unpacked in order that the sun may dry out the moisture that may condense within the hive near the entrance.

Generally speaking, it will be found best to do the spring work the previous fall, i. e., put all colonies in such condition that they will need no more attention until warm weather arrives. Beginners frequently do great damage to their bees by "fussing with them" in early spring before the flowers begin yielding nectar. A little carelessness at this time may cause robbing and create great disturbance and loss. If the bees show signs of robbing at any time, the operator, unless he is an expert, should cease work among the bees at once.

Any colony that may be queenless in early spring should be united with some weaker queenright colony.* It must be remembered that the only economic value of a worker bee in early spring lies in her ability to care for the young that she may be replaced by a half dozen young workers for the harvest. The bees that survived the winter will probably all have died some time previous to the honey flow. Therefore a colony of workers without a queen in early spring is of little value, but if these workers are given to a colony having a queen or mother bee, where they may help rear young bees, they are of the greatest possible value.



A RESULT OF EXCESSIVE SWARMING.

This colony of bees was too weak to withstand the winter. The bees died, with plenty of honey. There were not enough bees to form a good winter cluster.

It will not be found profitable to give a queenless colony a frame of brood and let them rear a queen this early. Of course, queens might be purchased from the South in early spring, but when one considers that a weaker colony may be put in condition to become a good colony for the harvest, by the addition of the queenless bees, it would not be profitable to try to build them up for an early honey flow by purchasing a queen.

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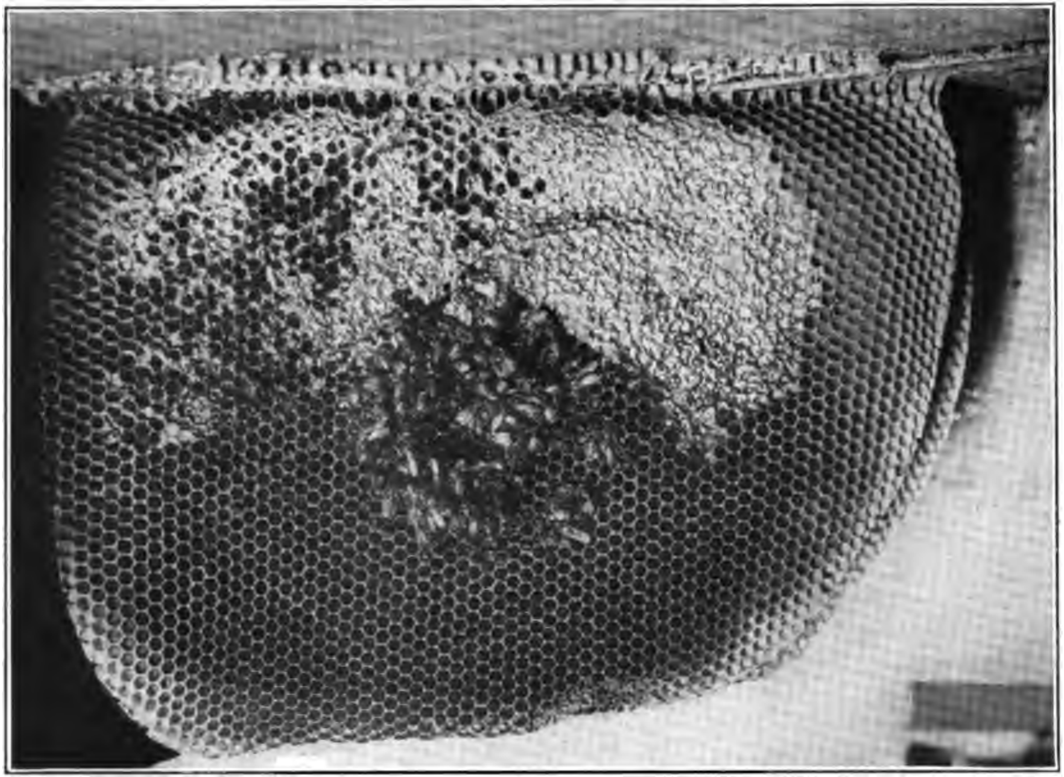
*A colony provided with a normal queen.



COMB TAKEN FROM HIVE SHOWN ON PAGE 238.

Note the sealed honey and the small number of bees that had formed the winter cluster.

The queenless colonies can usually be found in early spring without opening the hive, by noticing the flight of bees at the entrance. The queenless bees will be found less active in gathering pollen than colonies having a queen. Open the hive to see if the entrance diagnosis was correct, and if it has neither eggs nor larvae remove the bottom board and place the brood chambers on top of the uncovered queenright colony. It is well, in uniting, to place a newspaper containing a very small hole between the two brood chambers. This will usually cause them to unite peacefully.

During fruit bloom is a good time to clip the queen's wings. Open the hive with as little smoke or disturbance as possible, and lift out each frame carefully until the queen is found. The first frame or two should be left outside, providing the bees are not inclined to rob, that the operator may be able to see the side of the next comb before removing it. Watch this open space carefully, as the queen may run across the bottom board or ends of the hive to the combs already examined.

When the queen is found she may be picked up by the wings, using the thumb and forefinger of the right hand, then transferred to the left hand, holding her by the feet. This leaves the right hand free to use the scissors. Both wings on one side should be cut off. Clipping the queen's wings does not prevent swarming, but keeps the swarm from "going to the woods" and also greatly simplifies the management of swarms.

Any colonies that become crowded from want of room at any time previous to the honey flow should be given an extra hive body filled with empty combs. This should be placed below the brood nest, thus leaving the brood in the warmest part of the hive.

If there is no disease in the apiary, combs of brood may be drawn from the strongest colonies and given to those less strong. In thus equalizing the colonies frames of hatching brood may be used. Always make sure that the queen is not taken along. This brood should be given only to such colonies as *can take care of it,* never to very weak ones.

It sometimes happens that one colony may have too much honey and not much brood, while another may be short on honey any have an abundance of brood. An exchange of a frame or two will put both colonies in better condition. Colonies should never be equalized in this manner, however, if disease is in the yard.

It must be remembered that the workers that are to gather the nectar from the white clover are largely those hatched during the month of May. The beekeeper should, therefore, keep brood rearing going at the highest possible rate during the six or eight weeks preceding the honey flow.

A good supply of stores seems to be a stimulus to brood rearing, even during the worst weather, but if the stores become low brood rearing will be checked and may cease entirely, and the colony, of course, thus ruined so far as the clover flow is concerned.

It is well to keep at least one full reserve comb of honey in each hive during the time that workers for the harvest are being reared. Some beekeepers find it profitable to feed a small amount of syrup daily to further stimulate brood rearing. Feeding should, of course, cease before the supers are put on.

The most critical period in brood raising is during the time between fruit bloom and clover flow. There is an old saying among beekeepers that if the fruit bloom yields well the season will be good, but if the fruit fails the honey flow will be a failure. There is considerable truth in the statement, for if the hives are filled with honey from fruit bloom, brood rearing will go on without stint and the colonies are thus put in good condition for the honey harvest. The progressive beekeeper, however, brings about the same condition, even though the early flowers fail to yield nectar. This may be accomplished by inserting frames of honey, saved from the previous season, wherever needed.

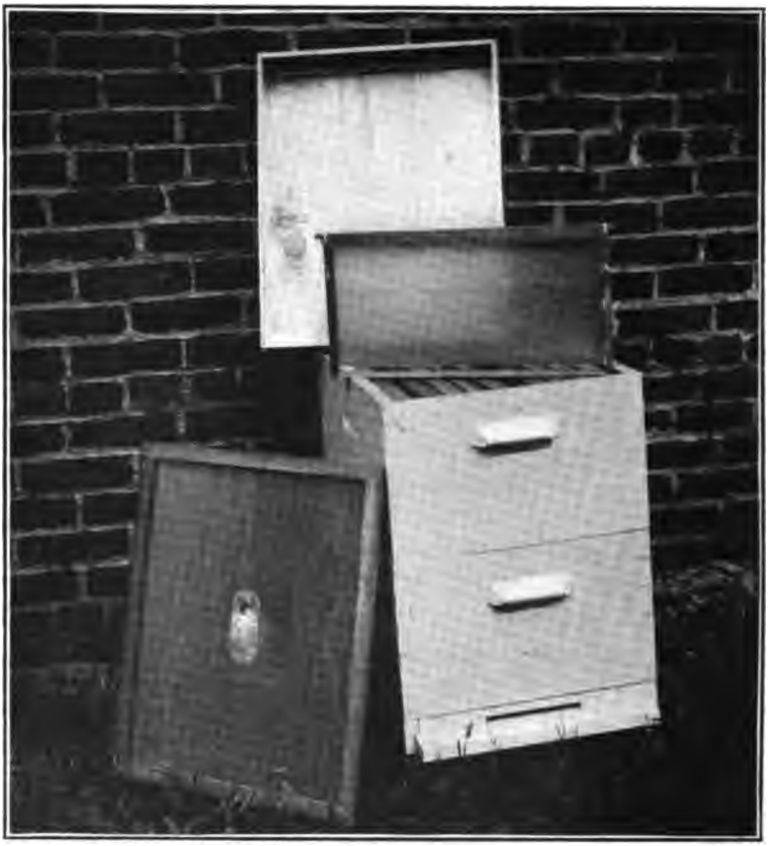
The essentials of spring management are:

1. *Each colony must have a good laying queen, queenless ones being united with weaker queenright colonies.*
2. *Each colony must have a supply of reserve honey throughout the time that workers for the harvest are being reared.*
3. *Colonies should be equalized, or if this cannot be done, on account of disease being suspected, the strongest colonies must be given an extra brood chamber, since one brood chamber will not furnish enough room for the strongest colonies previous to the honey flow.*

Just before the flow begins the supers should be put on. All colonies occupying two brood chambers should be reduced to one at this time and the extra frames of brood used to build up weak colonies. It is better to do this a little too early than too late, that swarming may be discouraged.

There should be no swarming before the early honey flow begins. In fact, except under peculiar circumstances, if the bees should swarm before beginning work in the supers, something is wrong with the management.

After managing to bring the colonies up to the beginning of the honey flow simply "boiling over" with bees and with the brood nest crowded with brood and honey, it would be folly to let them swarm and hive them on a separate stand. To allow them to do so would make from a strong colony two medium colonies, neither of which would be able to do much work in the super unless the season was greatly prolonged.



HIVE EQUIPPED FOR EXTRACTED HONEY PRODUCTION.

When the frames in the upper story are filled with honey, they are removed and the honey is thrown out of the comb by a centrifugal machine. The combs are then returned to be refilled.

To bring about the best results the entire working force of each colony must be kept at work in the same hive in the same set of supers until the flow is over.

If this can be accomplished without the bees developing the swarming fever, so much the better, but in the best regulated apiaries there will be some colonies that will attempt to swarm if the season is favorable.

In localities that furnish but a light flow in June, while the main flow comes in August, the management would be different, since increases could be made during the June flow and both colonies built up for the fall flow. It is only in such localities that increase previous to the main honey flow should be permitted.

If the beekeeper is operating but a single apiary and can be present during the swarming season, natural swarming may be allowed, but if several apiaries are operated by one man, or if other business requires his attention, some method of swarm prevention must be used.

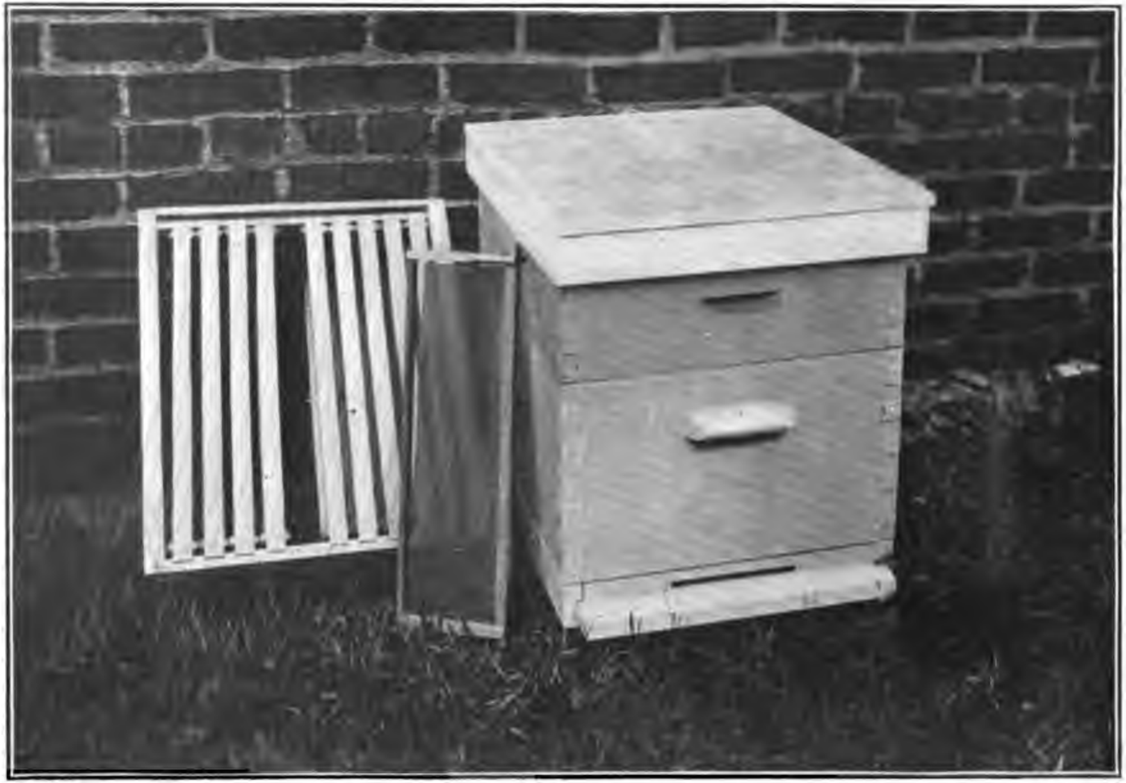
THE PRODUCTION OF EXTRACTED HONEY.

The simplest of all methods of swarm control is to give abundant storage room in the form of empty combs. This, of course, means the production of extracted honey. Hive bodies, just like the brood chamber, but containing empty combs, are used as supers. The queen excluder should not be used during the height of the swarming season, since confining the queen to one brood chamber, at this time, would tend to induce swarming. If the queen is allowed free range in the first super, as well as the brood chambers, and other supers containing empty combs are added above as fast as needed, the percentage of colonies that attempt to swarm should be very small. If the beekeeper is provided with enough empty combs to hold the entire crop it may all be left on the hives until after the close of the season. If the colonies are strong, as they should be, this will insure proper ripening of the honey.

Should the supply of empty combs become exhausted before the flow ceases, the ripest honey may be extracted and the combs returned to be refilled.

Some beekeepers allow the queen free range of the supers during the fore part of the season, then after danger of swarming is past confine her to the brood nest by inserting a queen excluding honey board.

Three weeks later any brood that may have been in the super will have hatched and the honey may be removed from the hive and extracted. If, however, the empty supers are all added *on top*



HIVE EQUIPPED FOR THE PRODUCTION OF "CHUNK HONEY," INTENDED FOR HOME USE OR LOCAL TRADE.

An excellent outfit for those who keep but a few bees.

the bees will gradually crowd the queen down into the brood nest towards the close of the flow, so that the same result is accomplished without the use of the excluder.

The honey should all be removed and extracted before the fall flow begins, to prevent its being mixed with the darker fall honey.

Considerable more extracted honey can be produced per colony than comb honey because the bees are saved the work of constructing new comb each time and also because swarming is more easily controlled.

Since the enactment of the pure food laws, the demand for extracted honey has been steadily increasing, and many producers are changing from comb honey to extracted honey production.

THE PRODUCTION OF BULK COMB HONEY.

Farmers and others who produce honey for home use only should use what the manufacturers list as "shallow extracting supers" instead of the regular comb honey supers. These supers contain shallow frames similar to those used in the brood chambers instead of the small section boxes. These frames should be filled with full sheets of thin super foundation.

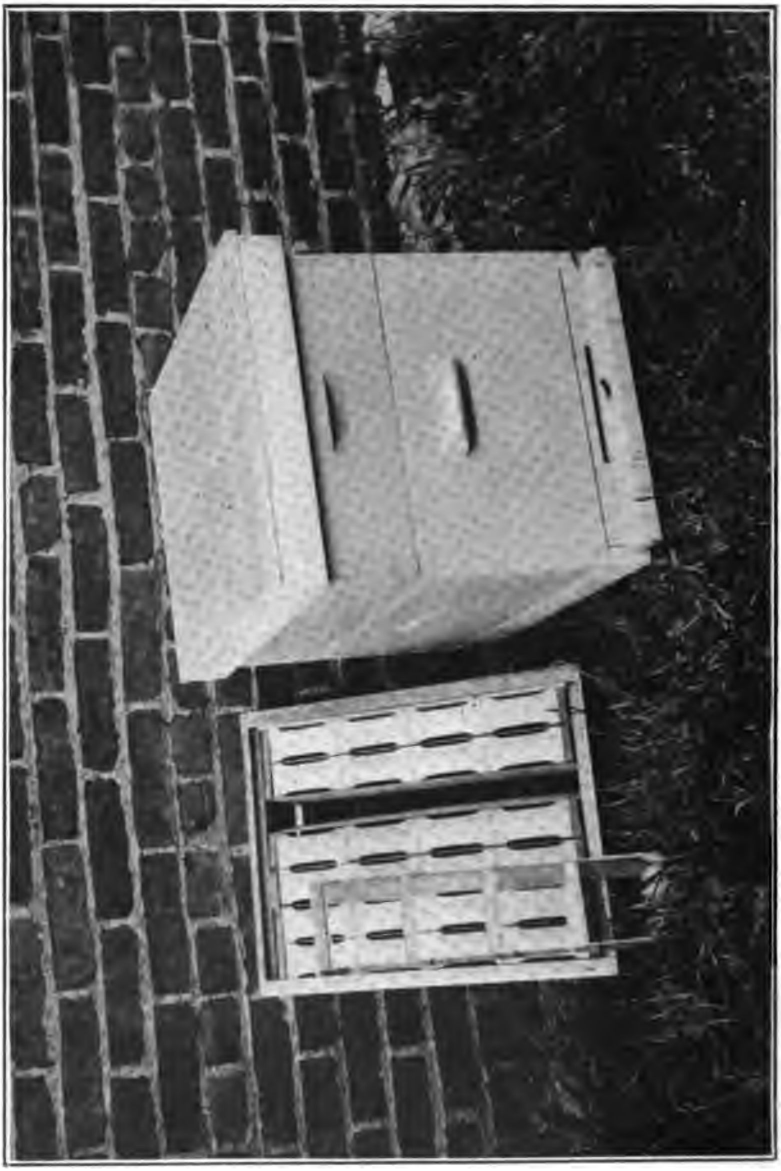
More comb honey per colony can be produced in this way than can be produced in the small boxes, because the super is not divided up into small compartments. After using the honey these shallow frames may be saved for the next season's use, thus saving the expense of new sections each year. Narrow strips of foundation could be used in these frames, but it is economy to use full sheets, especially if the flow is heavy.

THE PRODUCTION OF COMB HONEY.

In the production of comb honey the most serious problem is the control of swarming. The bees will not enter the sections and construct comb in the small spaces until all available space in the brood chamber is filled. This crowded condition tends to produce swarming, and swarming with the inexperienced beekeeper always means that storing in the sections will cease, at least temporarily.

With proper management, however, the colony that swarms can be made to produce as much honey as one of equal strength that did not swarm.

It is best to discourage swarming as much as possible,—then make the most of the stubborn ones that are determined to swarm.



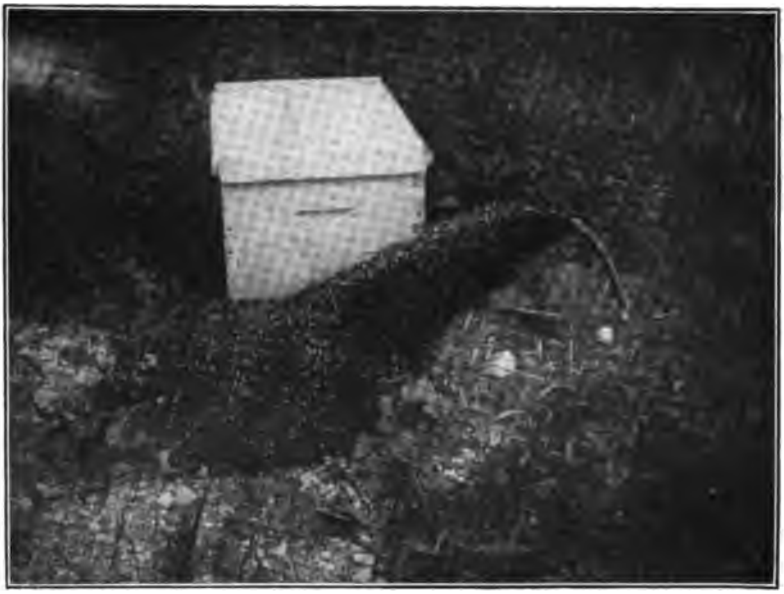
HIVE EQUIPPED FOR THE PRODUCTION OF COMB HONEY FOR MARKET.

The small boxes when well filled hold about one pound.

Some things that tend to discourage swarming are:

1. Plenty of room in the brood chamber before supers are adjusted.
2. Inducing the bees to begin work in the supers *early,* using a few drawn combs-("bait combs") in the first super.*
3. Adding super room as fast as the bees can use it.
4. Abundant ventilation and shade.

If natural swarming is permitted the queen's wings should be clipped, or queen traps should be used. When a swarm issues the queen, if clipped, will, of course, attempt to follow the bees. Since she is not able to fly she can readily be found on the ground in front of the hive. The queen, when found, should be placed in a small wire cloth cage. Now, while the swarm is out, set the old hive aside and put the new one in its place. When the bees discover that the queen is not with them they will return to their old location and enter the new hive, thus hiving themselves. When most of the bees have entered the new hive the queen should be released among them. Instead of clipping the queen's wings, queen traps may be used. These traps, while permitting the workers to pass freely, will automatically catch the queen in a separate compart-



A GOOD CATCH.

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*These "bait combs" are simply the unfinished sections saved from the previous season.

ment when a swarm issues. The old hive is then moved aside and a new one set in its place, after which the trap still containing the queen is placed over the entrance of the new hive. The swarm will return to the new hive and hive itself. The tin slide in the trap should now be withdrawn, so that the queen may enter the hive.

The trap should be left on the new hive a few days to catch the queen in case the colony should swarm out, but should afterwards be removed. Should more than one colony swarm at the same time they may unite, and in returning all return to one location. The beekeeper must then remove the hive when a sufficient number of bees have entered and put another in its place, or otherwise separate them.

If the new hive contains frames with narrow strips of foundation and the supers of partly filled sections are transferred from the parent colony to the new swarm at the time of hiving, there being no cells below in which to store honey, the bees will begin work immediately in the same set of supers they were, but a few minutes before, so eagerly deserting.

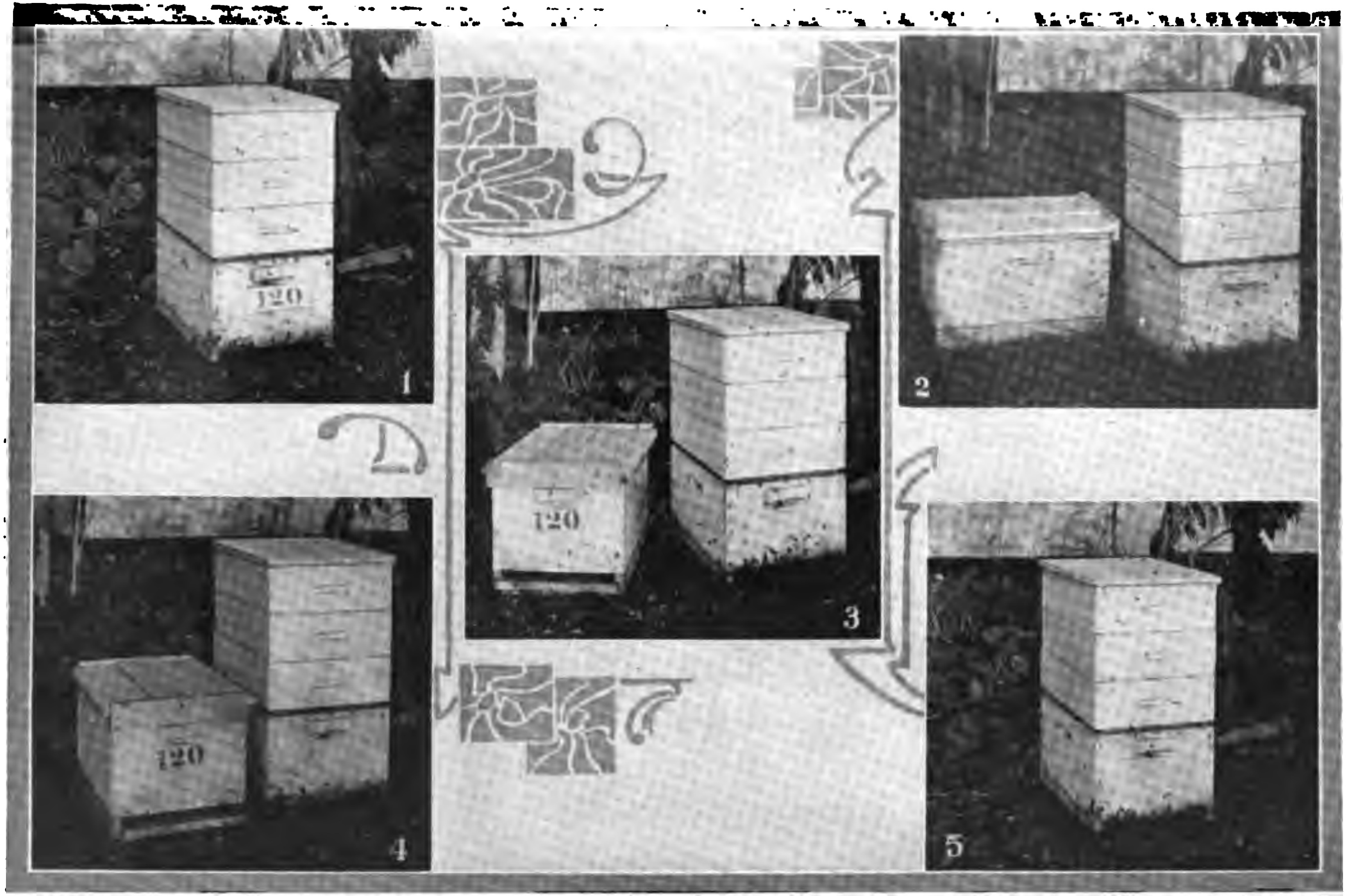
Under these conditions work in the brood nest goes on slowly, the energy of the colony going largely to super work.

When the supers are thus transferred at the time of hiving, and no empty comb is used in the brood chamber, a queen excluding honey board must be used or the queen would enter the sections.

After three or four days, when there is no longer danger of the swarm attempting to leave, the brood chamber may be contracted to five frames by removing the extra frames and placing "dummies" or division boards in their stead. This arrangement forces the honey into the supers, leaving the brood nest almost destitute of honey at the close of the season.

A swarm should never be hived on a full set of empty combs when section honey is desired, for this reverses the conditions given above and practically all the work will be done in the brood nest until it is filled, after which the bees are slow about entering the supers. If empty combs are used at all for this purpose, not more than five should be given, the remaining space being filled with dummies.

The parent hive, which was turned aside at the time of hiving, is gradually turned back until it stands close by the side of the swarm. One week later, open the parent hive and shake the bees from all of the combs except two, shaking them, of course, in with the new swarm. The bees are left on the two combs to care for the remain-



THIS SERIES OF PICTURES SHOWS THE METHOD OF HANDLING A COLONY THAT SWARMS, SO THAT THE WORKING FORCE IS KEPT IN THE SAME HIVE.

ing brood. The parent hive should then be moved entirely away, so that all its field workers will be thrown into the new swarm.

No surplus is expected from the parent colony during the early flow, but such colonies build up rapidly and should be in good condition for fall flow.

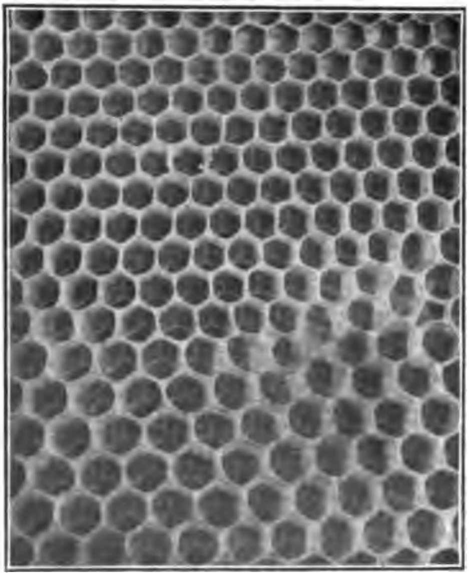
By this method practically the entire working force is kept together throughout the honey flow and super work should go on without interruption.

Contracting the brood chamber to five frames during the honey flow is of especial advantage during a short flow as from basswood or clover, but should be used with caution. As soon as the flow is over the dummies should be removed and combs inserted to complete the set, so that the bees may have enough room for brood and stores.

If no increase is desired the swarm and the parent colony may be united at the close of the honey flow.

All combs built from narrow strips of foundation should be sorted and those containing drone combs rejected, though it is a little better plan to build all brood combs from full sheets of foundation.

This insures the maximum number of cells of worker size on each frame. If one man is caring for several apiaries, or if the apiarist has other business that takes him away from the bees a greater portion of the time, a very satisfactory method of swarm control is to remove the brood from such colonies as are determined to swarm. This method necessitates the opening of each hive every six days during the swarming season. If no queen cells are present the colony is safe, so far as swarming is concerned, for another six days. If queen cells containing an egg, or a very small larva, are found, they should be destroyed,



The small cells are the worker size. The large cells are drone size. The irregular cells are called "transition cells."

and frequently the colony makes no further preparation for swarming, but turns its attention to super work.

If, however, well advanced queen cells are found, the colony would probably swarm, even though all the queen cells are destroyed. Now shake most of the bees from the combs into a new hive on the old location, being sure that the queen is put into the new hive.

Leave the adhering bees on two combs to care for the brood. The old hive, with the combs of brood and few adhering bees, is set aside with the entrance turned away, that all the field bees may return to the newly made swarm. The supers that were on the parent hive should be placed on the new hive with a queen excluder between.

One week later again shake the bees clean from all the combs except two in the old brood chamber, adding them, of course, to the forced swarm of the week previous. Now move the old hive, with the remaining brood and bees, to a new stand and give it a young queen or a cell that is nearly ready to hatch. The parent colony should not be allowed to raise its own queen, for it was robbed so closely of bees that it would probably raise a poor one.

Removing all the brood at once is quite a shock to the colony, and sometimes results in the colony swarming out the next day after forcing the swarm. This may be avoided by removing all but five or six frames of brood at the time of forcing the swarm, then removing the remaining combs of brood a week later and inserting dummies in their stead.

When the brood is not all removed, full sheets of foundation must be used in the frames or drone comb will be built, and care must be taken that no queen cells are left on the combs of brood that were left in the hive.

With this method the bees do not seem to realize that their brood has been removed and super work is not interrupted.

MANAGEMENT OF SUPERS.

Comb honey supers should be prepared in advance, at least four supers for each colony, spring count. Each section should contain a full sheet of foundation and the first super should have one or more sections of drawn comb.

If the bees are storing rapidly and the colony is strong, a second super should be given as soon as the combs are well drawn out in the first super. The first super should be raised and the second placed under it. Other supers are added in this manner as fast as needed. During a heavy honey flow the bees may be building comb in several supers at once, giving large storage space for the thin nectar, thus approaching the conditions of extracted honey production.

If no other supers were added until the first super is finished, there might be a loss of from one to four supers that would have been filled while the honey in the first super was being ripened and sealed. It is well, however, to use caution in expanding the surplus room, as the season may close, leaving none of the sections finished. If the flow is slow, or the end of the season is approaching, the empty super should be placed on top of the others. If the bees enter it and begin work it may be placed below later.

The finished supers may be removed by means of a bee escape, or the bees may be driven out by means of smoke.

The essentials of management during the honey flow are:

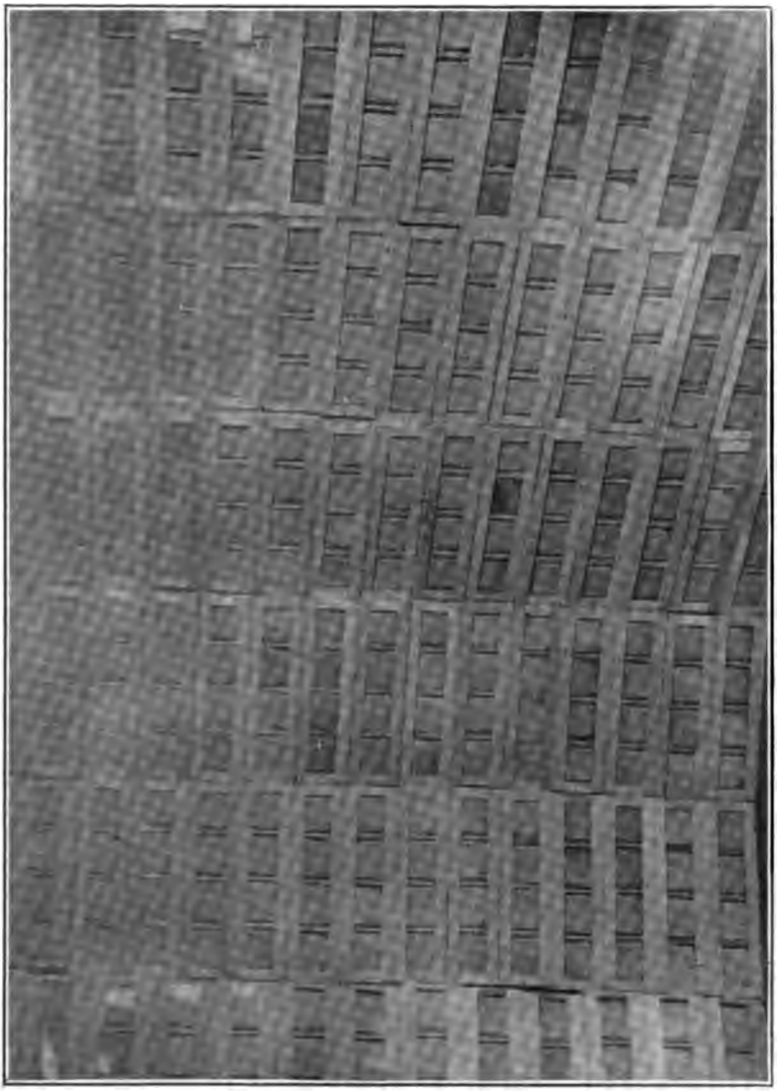
1. *Manage that the bees begin super work before developing the swarming fever.*
2. *Keep the entire working force at work in the same hive throughout the season, even though the colony should swarm.*
3. *Add super room as needed.*
4. *Remove finished honey.*

''Keep all colonies strong'' is an axiom in beekeeping. Literature on beekeeping is full of this advice, and yet even some of the veterans do not seem to realize the possibilities of strong colonies. Much has been said about keeping the colonies strong during the honey flow and restricting brood rearing during the non-productive periods to prevent a horde of useless consumers when nothing could be gathered from the fields. But somehow a strong colony seems to be better able to make a living between flows than one of medium strength, and probably consumes less honey per bee during the winter than medium or weak colonies.

It can readily be seen that the larger winter cluster has fewer bees exposed on the outer surface in proportion to the total number than has the smaller cluster.

It must be remembered that we are more concerned in wintering a great number of bees than we are in wintering a great number of hives.

In most of the apiaries visited in Indiana during the past two seasons it would have been better for both bees and beekeeper if all of the bees had been in one-half the number of hives.



ABOUT A TON OF INDIANA COMB HONEY READY FOR MARKET.

SUMMARY.

In this outline it has been assumed that the primary object in keeping bees is the production of honey. Of course, bees may be kept for other purposes, and the production of honey may in such cases be of secondary consideration. This is true of the specialists engaged in rearing queen bees for sale and those making a business of selling bees by the pound or colony, and also of others who may keep bees for experimental purposes or scientific research.

In its last analysis, however, the ultimate purpose of nearly all beekeeping is the production of honey.

Of all the bees that are reared during the season, it is only those that are present at the beginning of and during the honey flow that can actually help gather and store the crop of honey. The other generations of bees reared at other times are valuable only because they may be the means of bringing into existence these workers for the harvest.

The young bees reared in August and September are valuable only in as much as they may be able to withstand the winter and replace themselves with young the next spring. The beekeeper must, therefore, see that the proper conditions are present for the rearing of these bees that are to bridge over the life of the colony during the winter and must conserve their energy as much as possible that they may be able to replace themselves with young in the spring. Simply bringing the colony through the winter alive does not necessarily mean good wintering.

In the spring the primary object is the rearing of the greatest possible number of workers for the harvest. Anything that the beekeeper can do that will increase the amount of brood reared at this time should, of course, increase the amount of honey secured.

After the honey flow begins, the generation of bees that has been brought into existence for the purpose of gathering and storing the crop of honey should be used to the best possible advantage. The bees of a colony should not be permitted to divide their forces into several weak, or medium colonies, by swarming, but should be kept together in spite of their swarming instinct. Neither should they be compelled to loaf for want of room to store the newly gathered nectar, or from lack of ventilation or shade, but should be induced to expend the greatest possible amount of energy in gathering and storing, for the harvest time is of short duration.

BEE DISEASES.

The two infectious diseases of the brood of the honey bee, known as American Foul Brood and European Foul Brood, are both widespread in Indiana.

These diseases weaken and finally destroy the colony by destroying the brood. When the colony finally dies the neighboring colonies carry out the remaining honey, thus carrying the disease to other colonies. If the beekeeper does not interfere and treat the diseased colonies, the disease soon spreads through the apiary and finally throughout the entire community, causing great loss and annoyance.

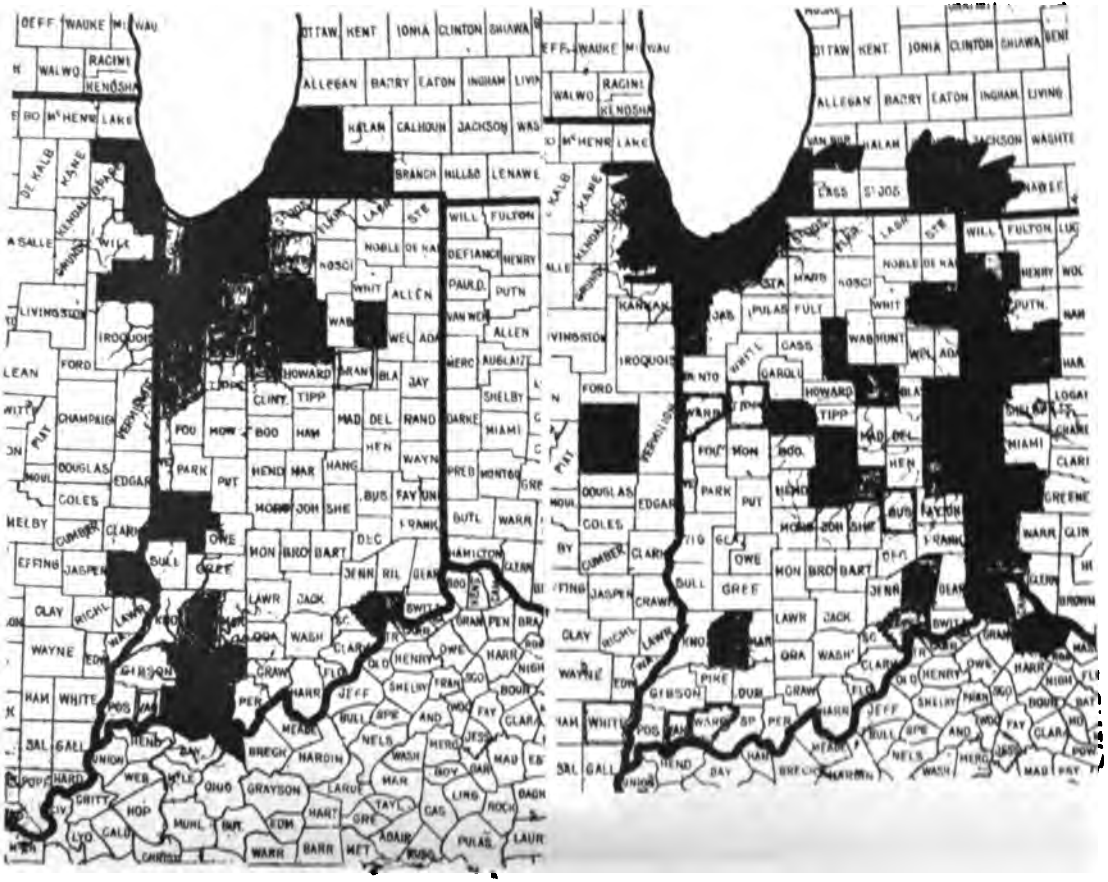
Since the diseases do not attack the adult bee, it is necessary to open the hive and examine the brood in order to detect the trouble, except the more advanced cases, which may be detected by the odor.

The following table of comparative symptoms should enable any careful person to detect and differentiate the diseases. It is important that the beekeeper should be able to distinguish between the infectious brood diseases and brood that may have died from other causes, such as pickled brood, chilled brood, etc.

Table of Comparative Symptoms.

AMERICAN FOUL BROOD.	EUROPEAN FOUL BROOD.	PICKLED BROOD.
Color at first, light chocolate.	Color at first, yellow.	Color at first, light yellow.
Darkens with age until dark brown.	Darkens with age until almost black.	Darkens to brownish color.
Dead larvæ become shapeless mass on lower side of cell.	Dead larvæ may become shapeless mass, but very young larvæ may remain coiled in bottom of cell.	Dead larvæ usually retain shape, though swollen.
Attacks larvæ about the time of capping or soon after.	Attacks larvæ usually before time of capping.	Attacks larvæ about time of capping.
Combs show sunken and perforated cappings; discolored.	Very seldom shows sunken perforated cappings.	Cappings may be perforated but not discolored.
Dead material is ropy. Larvæ die down to tightly adhering scale.	Ropiness almost or entirely wanting. Dried larvæ form scales not tightly adhering to cell.	Never ropy but is watery. Usually Removed.
Odor is foul, noticeable even when a few cells are diseased.	Odor not noticeable except in most advanced stages when it resembles odor of American Foul Brood.	Very slight odor.
Seldom attacks drone or queen cells.	Disease attacks drone and queen cells among the first.	
Spreads slowly.	Spreads rapidly.	Supposed not to be contagious.

NOTE.—For a more detailed description of these diseases see the Second Annual Report.



TWO MAPS SHOWING THE DISTRIBUTION OF EUROPEAN FOUL BROOD AND AMERICAN FOUL BROOD.

The data from surrounding states has been obtained from Dr. Phillips, of the U. S. Department of Agriculture. The shaded counties are the ones in which disease has been found at some time. It is probable that some of these counties are now free from disease. Of course many apiaries in infected counties are perfectly healthy.

DISTRIBUTION.

American Foul Brood has been found in the following counties: Lake, Porter, Newton, Vanderburgh, Allen, Miami, Grant, Elkhart, Warren, Jay, Randolph, Daviess, Wayne, Hamilton, Marion, Laporte, Hancock, Ripley, Jefferson, Clinton.

European Foul Brood has been found in the following counties: Lake, Porter, Laporte, Spencer, Warren, Newton, Jasper, Pulaski, Daviess, Vigo, Starke, Marshall, Fulton, Benton, Jefferson, Cass, Miami, Huntington, White, Dubois, Clay, Pike, Warrick, Carroll.

AN INSPECTOR-PROOF BEE HIVE.

Both cover and bottom are *nailed* fast. In such cases the hive is often destroyed by the inspector.

European Foul Brood is spreading rapidly, and its control presents quite a serious problem to beekeepers. It is much more treacherous than American Foul Brood, in that it frequently disappears temporarily, leaving the owner under the impression that he is rid of the trouble. For this reason it frequently lurks in an apiary year after year, until the owner finally recombs the entire apiary.

The treatment of either of these diseases consists simply in taking all the combs and honey from the bees and compelling them to build new combs from *narrow strips* of *foundation.* Full sheets of foundation should not be used, and drawn comb must never be used in treating brood diseases. The bees may be brushed or shaken from the diseased combs, or driven from the hive by smoke, or drummed out, as the operator finds best.

The most important part of the treatment is the final destruction of the combs and honey to prevent reinfection. They should be burned or buried, or melted up for wax. If the diseased brood is permitted to hatch it should be placed on a colony that can protect it from robber bees, and at no time in the operation should the combs be exposed when bees are flying.

This work must all be done with great care, since a drop of honey carelessly left exposed may be enough to cause the disease to reappear. Remember that the bees will find drops of honey that the operator may not see.

The interior of the hive should be scorched out before using again to prevent any possible infection from that source.

It should be noticed that the treatment here advised is practically the same thing as the artificial swarming of bees, as described elsewhere in this report, and unless the colonies have been greatly weakened by the disease, the treatment need not interfere materially with the production of a crop of honey.

The intelligent beekeeper will not quit business because of the prevalence of bee diseases, but will so manipulate his colonies that the loss will be reduced to the minimum.

During the past season the writer saw many colonies that had stored one hundred or more pounds of comb honey after having been treated for Foul Brood.

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